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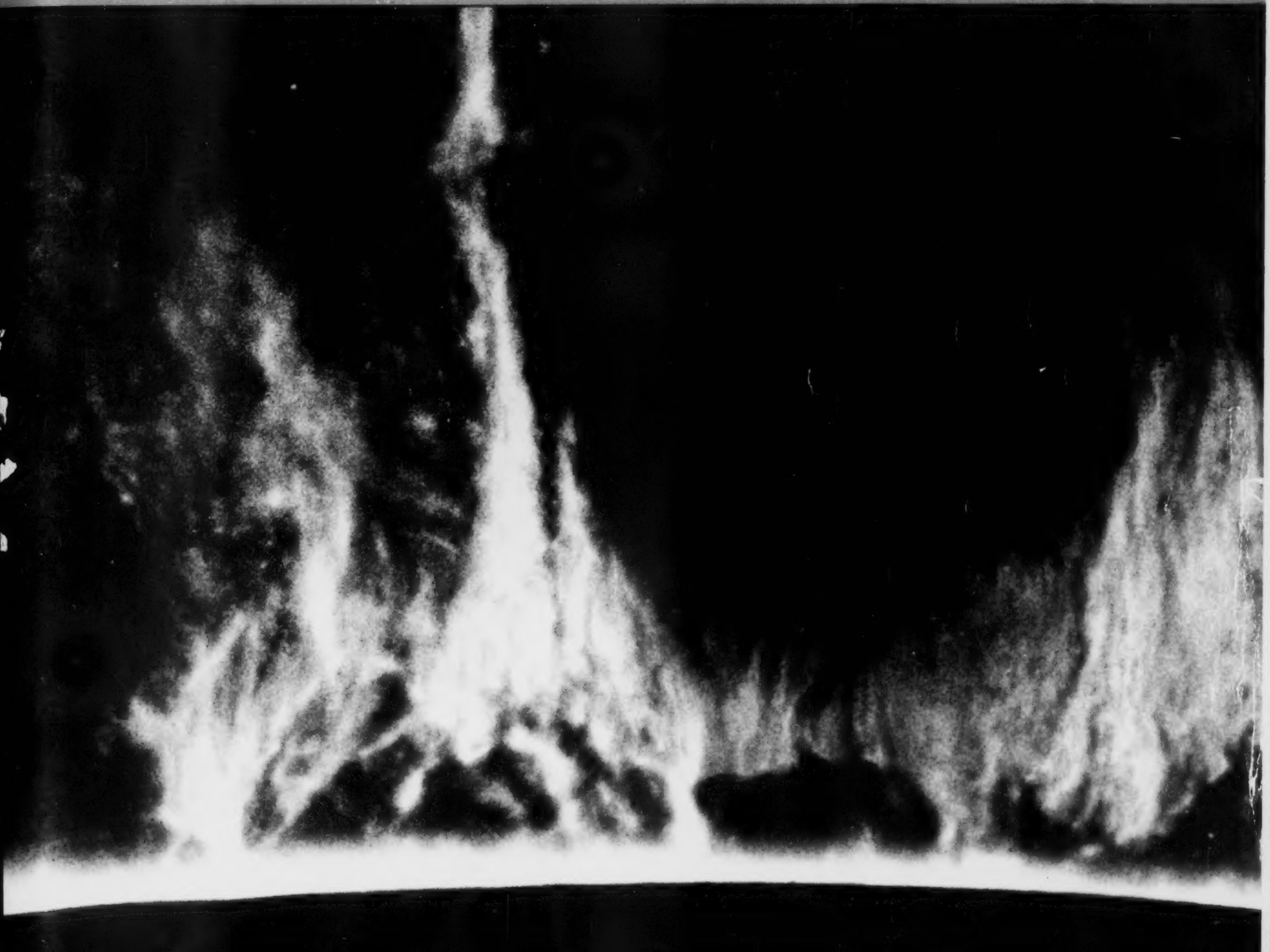

Hedgerow prominence on the sun

In This Issue:

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Vol. XVI, No. 10
AUGUST, 1957
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Sky and TELESCOPE

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COVER: This fine hedgerow prominence on the edge of the sun was photographed on September 20, 1956, with the 15-inch chromosphere camera at Sacramento Peak Observatory in New Mexico. The picture was obtained in red light, with a filter transmitting hydrogen-alpha radiation. On the original negative the solar image has a diameter of 9½ inches; here it is enlarged about eight times. Sacramento Peak Observatory photograph. (See page 464.)

SKY AND TELESCOPE is published monthly by Sky Publishing Corporation, Harvard College Observatory, 60 Garden St., Cambridge 38, Mass. Second-class mail privileges authorized at Boston, Mass.

Subscription: $5.00 per year in the United States and possessions; $9.00 for two years; $13.00 for three years. Add $1.00 per year for Canada, Mexico, and all countries of the Pan American Postal Union, making the total subscription $6.00 for one year; $11.00 for two years; $16.00 for three years. Add $2.00 per year for all other foreign countries, making the total subscription $7.00 for one year; $13.00 for two years; $19.00 for three years. Canadian and foreign remittances should be made in United States currency. Single copy 50 cents. Back numbers, as available, 50 cents each.

All notices of change of address must be sent one month in advance and accompanied by old and new addresses. When sending your renewal order, or writing in regard to your subscription, your current mailing address must be given. Please return our bill form with your renewal payment. Circulation staff: Nancy R. Bolton, manager; Helen B. Sniegiecki; Stacia Strong.

Editorial and advertising offices: Harvard College Observatory, Cambridge 38, Mass. Advertising manager, Henry M. Corrado. Advertising rates are listed in STANDARD RATE AND DATA SERVICE, or sent upon request.

Unsolicited articles and pictures are welcome, bearing adequate return postage, but we cannot guarantee prompt editorial attention, nor are we responsible for the return of unsolicited material. Editorial assistants: Virginia K. Cox; Elizabeth C. Merrylees; William E. Shawcross. The principal articles are indexed in THE READERS' GUIDE TO PERIODICAL LITERATURE.

Word from Down Under

YOUNG STUDENTS of astronomy here in the Southern Hemisphere are sometimes a little handicapped in their early studies because nearly all of the available textbooks are written by northern writers for northern readers. Atlases and star charts, too, mostly reach us from America or England, where the night skies are seen from an angle differing by as much as 90 degrees from our view in Australia.

To illustrate this problem, let us listen in on a recent dialogue under a clear sky at about 35° south latitude. In the east Orion could be seen above a range of mountains, and to its south Sirius was twinkling vigorously, as two stargazers were regarding the heavens:

Alpha (the pupil). "There's Orion over there with Rigel at top right. Why do star charts show Rigel at bottom right?"

Omega (the teacher). "That's Northern Hemisphere orientation. You see, the astronomers up north view the constellations upside down and the charts are drawn accordingly."

Alpha. "Couldn't the charts be made to suit our skies?"

Omega. "Yes, but then they'd be wrong for northern students."

Alpha. "Of course—but it's still very confusing. The books say the sun is due south at noon. Tell me, sir, do we ever see the sun due south at noon?"

Omega. "No, it is always due north at noon for us. But you must make allowances for those northern writers on astronomy. They are in the antipodes hanging head downward and they cannot be expected to think of us standing upright down here."

Alpha. "And the textbooks say the stars go around the pole counterclockwise, but here they are, in front of our eyes, going around clockwise."

Omega. "Turn round, face north, and work it out for yourself, but remember that most of those northern writers have probably never seen our south circumpolar stars."

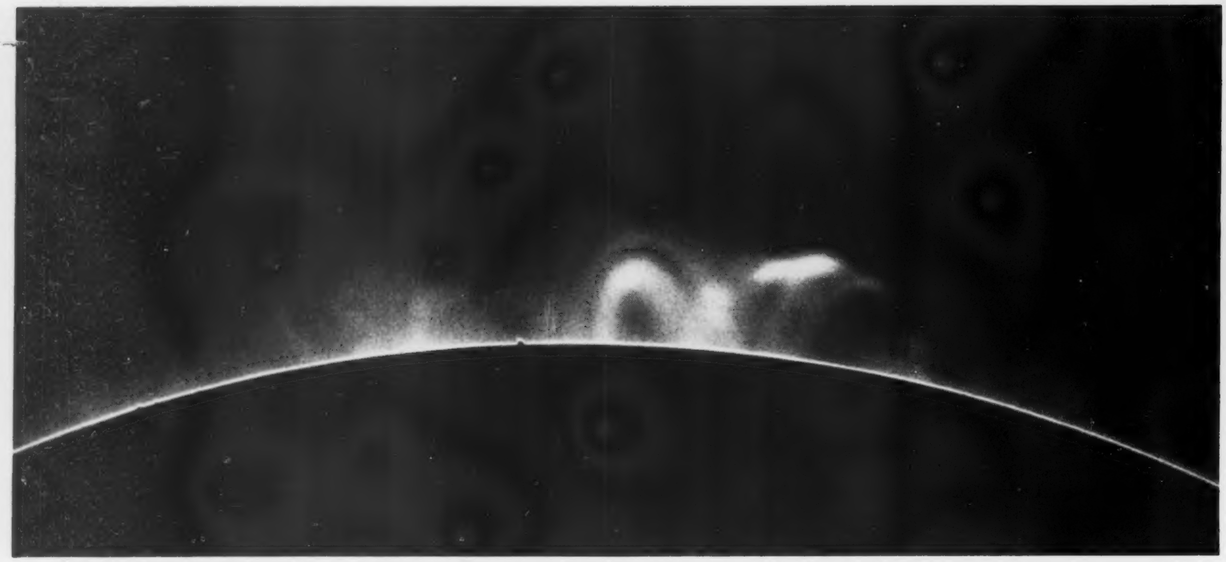
Alpha. "And how can a stake in the ground throw a shadow to the north—on the same side as the sun?"

Omega. "Well, that shadow would certainly be worth seeing. Any more complaints?"

Alpha. "Yes, they say the spring equinox is in March. Tell me, sir, how can the spring equinox occur in autumn?"

Omega. "They surely ought to change vernal equinox to March equinox. Say, why not write a letter to one or two of those northern writers and tell them a few things they ought to know?"

(Continued on page 481)



Spectacular loops in the sun's corona photographed in the light of the 5303 line of Fe XIV at 16:23 Universal time, November 22, 1956. These unique coronal formations coincided with intense limb prominences in hydrogen-alpha light. This is an enlargement of the first frame in the series on page 466. All solar photographs with this article are from Sacramento Peak Observatory, Sunspot, New Mexico.

Some Advances in Solar Research

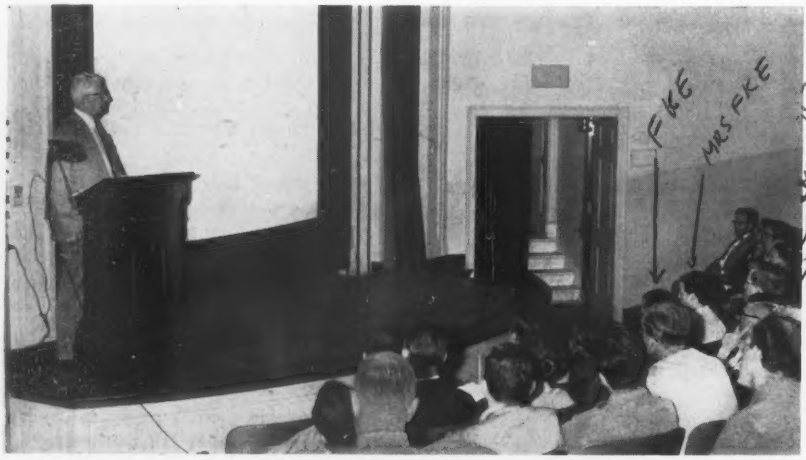
DONALD H. MENZEL, *Harvard College Observatory*

NEARLY three decades ago, two great epoch-making advances were achieved in methods of observing the sun. At the McMath-Hulbert Observatory motion-picture techniques were applied to prominence photography, and in France Bernard Lyot showed that by means of a special telescope—called a coronagraph—the solar corona could be observed outside of total eclipse.

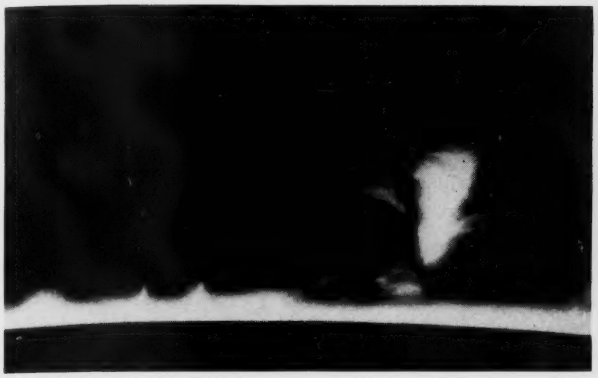
Before hearing of Lyot's success, the writer had been working on a photoelectric scanning device for electric removal of the sky illumination around the sun. The preliminary results were encouraging, but the coronagraph seemed to have the greater future, and a small one was built at Harvard, the first in the United States. It was installed at Climax, Colorado, where Walter O. Roberts began the work of what is now the High Altitude Observatory, with its headquarters at the University of Colorado in Boulder.

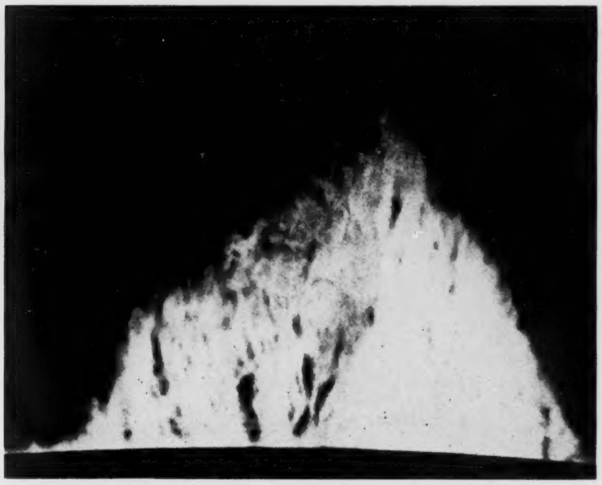
During the second world war, I was associated with the Interservice Radio Propagation Laboratory, which provided the military with forecasts of solar disturbances that might interfere with radio communications. The predictions were based on observations from Climax, the McMath-Hulbert Observatory, and Mount Wilson Observatory. Despite the fact that most of the war was fought near the time of sunspot minimum, the effects of variable solar activity on radio communication were very evident. This program is today being carried on by the Central Radio Propagation Laboratory of the National Bureau of Standards at Boulder.

At least one other major coronagraph in the United States seemed necessary to give more complete daily records, especially during seasonal cloudiness at Climax. Marcus O'Day, of the Air Force Cambridge Research Center, and I conducted a two-year site survey for a second coronagraph. We selected the Sacramento Mountains in New Mexico, to the east of Alamogordo, and there the Air Force has built a solar observatory (*Sky and Telescope*, August, 1956, page 436). Since then, the Harvard solar program has grown with the support and close collaboration of the Air Force.



Before the members of the American Astronomical Society, at the May meeting in Cambridge, Massachusetts, the director of Harvard Observatory, Dr. Donald H. Menzel, delivers the retiring president's address on which this article is based. Photograph by Betty Merrylees.



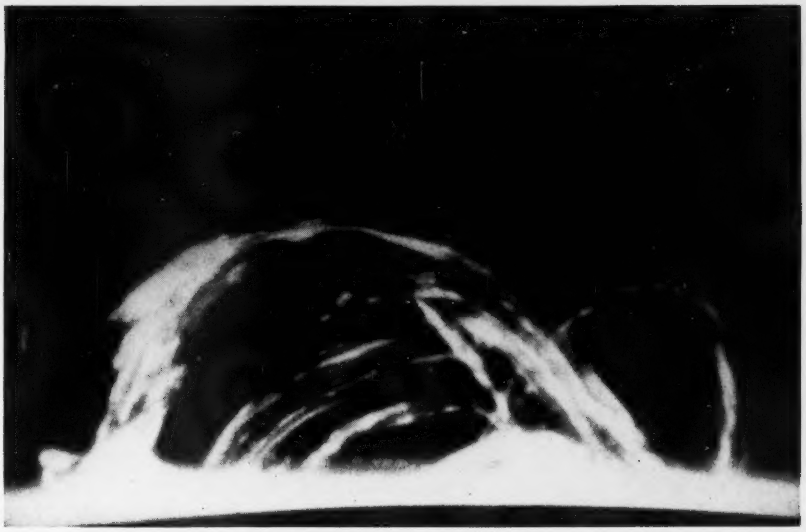


Above: The funnel seen here has breaks in its sides through which matter is streaming in long arcs to the solar surface. Right: A hedgerow prominence, of which type another example is seen on the front cover.

This article is a brief summary of my remarks as retiring president of the American Astronomical Society at its May, 1957, meeting, at which time I showed a new compilation of motion pictures of the sun, chiefly from observations at Sacramento Peak Observatory during 1955 and 1956, and including some photographs with the 15-inch chromosphere telescope and the 16-inch coronagraph. These films are remarkable for the great structural detail exhibited by both prominences and solar corona.

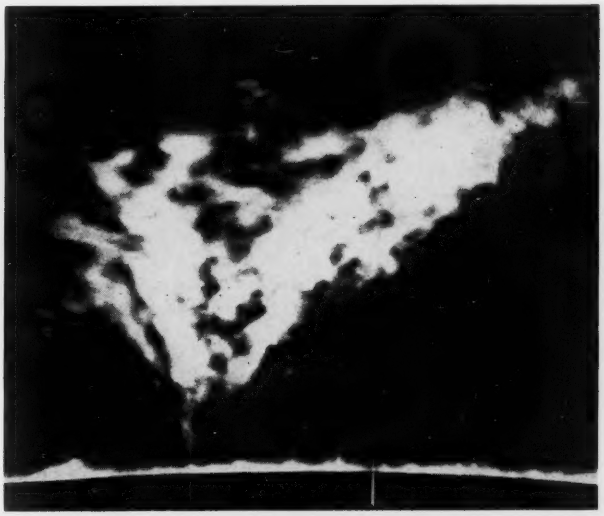
Sequences were shown of "hedgerow" prominences, which also appear as dark hydrogen filaments in monochromatic pictures of the sun's disk. This kind of prominence is not associated with sunspots. The hedgerows typically have a fine filamentary structure and often tend to form arches. Under special conditions, the arch ascends in a spectacular display of enhanced activity.

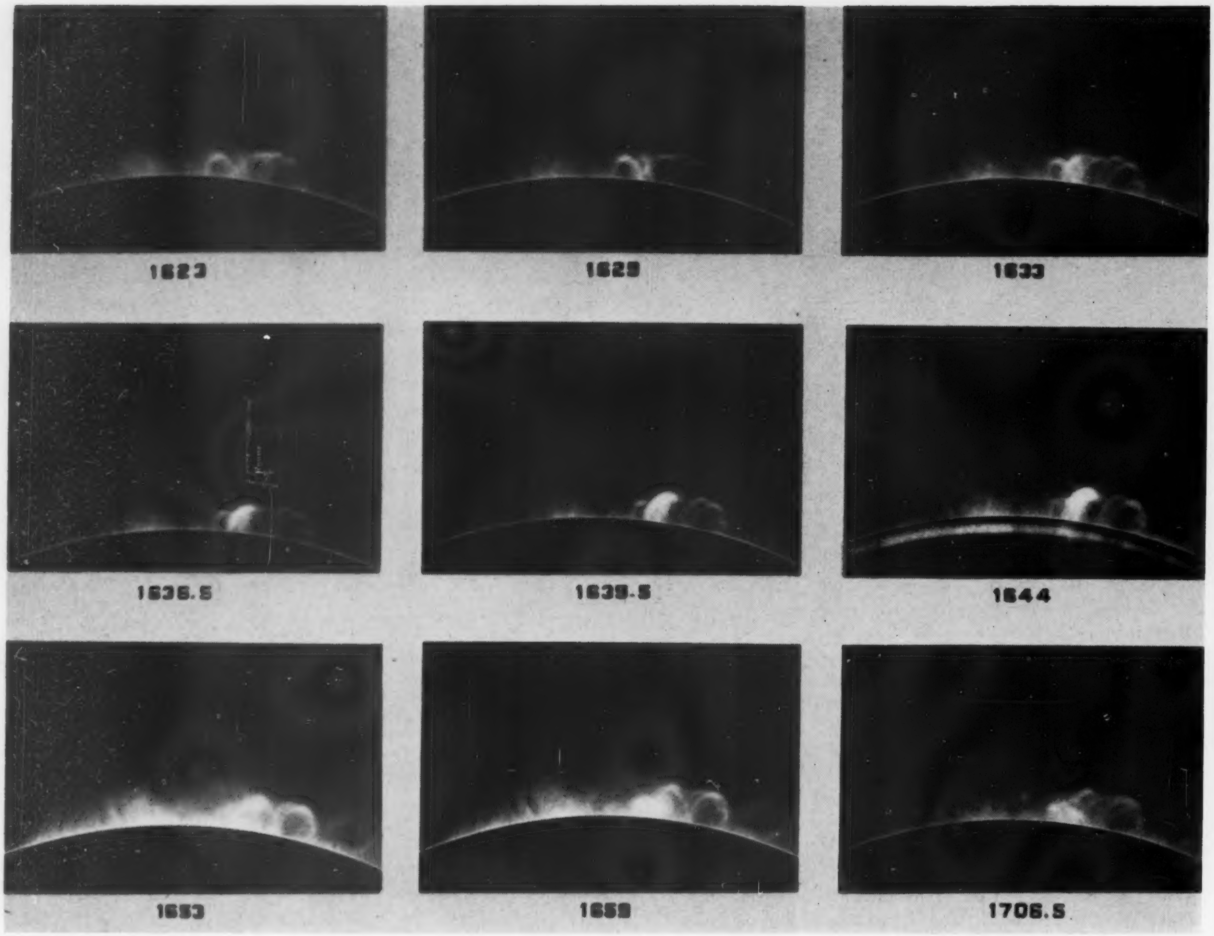
Loop prominences, occurring in sunspot regions, contain matter condensing from above and falling in graceful curves toward the sun's surface. Occasionally very bright loops are formed at high levels



The pictures on this page were made with the Sacramento Peak 15-inch chromosphere camera. They show small solar prominences on a large scale. The one above, of an intricate arrangement of prominence loops, was taken October 7, 1956. The others on this page were made on three days in September, 1956: on the 12th, lower left; 13th, upper left; and 14th, upper and lower right. The reproduction prints are courtesy of Richard B. Dunn.

Above: A prominence that may be of the hedgerow type, seen along its length; spicules in the chromosphere are visible above the occulting disk's edge. Right: A funnel-type prominence, illustrating the magnetic focusing effect.





The solar corona on November 22, 1956, photographed in the light of ionized iron (Fe XIV) at wave length 5303 angstroms, with the 6-inch coronal camera of Sacramento Peak Observatory. The first frame in the upper left is shown enlarged on page 464. The labels beneath the frames give the Universal time, and indicate the rapidity with which these looped structures in the inner corona changed.

and then grow downward on both sides. I believe that the initial stages of such formations would actually appear as flares, if seen against the sun's disk.

Related to the loops are funnel-type prominences, where matter flows from an invisible coronal source into a region with a sharply bounded top. The rapidly descending material is further compressed, but breaks through the side of the funnel at various places and falls to the solar surface along gently curved paths. This flow is probably parallel to magnetic lines of force, whose position is in turn determined by the moving matter. The more intense fields encountered near the funnel boundaries act as barriers to the flow. This concept accounts for the tendency of neighboring jets and surges of prominence material to avoid the funnel.

Pictures of the chromosphere were made by Richard B. Dunn, who took four different types of photographs simultaneously *(Sky and Telescope*, February, 1956, page 152) to show the structure of the chromosphere in hydrogen-alpha light and in the neighboring continuum outside that line. Other sequences are of hedgerow prominences, the large scale and high resolution of the 15-inch chromosphere camera revealing details hitherto unobserved with such ease (see front-cover picture); in these films the effects of atmospheric seeing are evident, as some parts of the field are very sharp for a few seconds and then distorted, while other parts are first fuzzy and then sharp.

The disk photographs emphasize the rapidity with which flare phenomena occur in the vicinity of a sunspot, and also illustrate the actual ejection of matter from a flare. In the areas of flares a strong pulsation or boiling is present, with frequent changing of a bright region to a dark one, caused evidently by the opacity of the overlying clouds of expelled gas. In one case the actual speed of flare growth cannot be determined because the flare developed between successive frames of the lapse-time sequence!

A narrow-band filter transmitting the coronal green line from iron atoms ionized 13 times gives some surprising pictures of actual motions in the corona. In several examples, bright coronal patches appear and then fade away, leaving what seems to be a dark hole. In another series, a low-level flare gives rise to a shock wave that rapidly moves up through the corona, whose streamers wave back and forth with whiplike motion. In one of the most spectacular sequences, loop formations develop which show some resemblance to loop prominences. The details of the activity are, however, very different, although loop prominences in hydrogen light were simultaneously present.

My views of the nature of the sun's activity and of the processes giving rise to the various solar formations have developed from the co-operative Harvard research program, with the collaboration of Max Krook, Richard Thomas, David Layzer, Grant Athay, and others. Some of these associates do not subscribe to all the details of my interpretation presented here.

The sun's hydrogen convective zone would seem to be the source of solar activity. The forces involved appear as electric currents, magnetic fields, and

gravitation. The convection raises hot gas from lower levels, altering the vertical temperature gradient. As a result, the sun appears much more brilliant than it would if the solar atmosphere were in pure radiative equilibrium. The evidence indicates that the convective layer extends to higher atmospheric levels and that vertical flow is more significant than conventional models would allow.

As the German astronomer L. Biermann has pointed out, the intense magnetic field of a sunspot tends to inhibit convection, so that in the spot the upper layers are cooler than in the sun's atmosphere generally. The sunspot thus appears dark by contrast. This conclusion completely reverses the conventionally accepted model of a sunspot as a storm area. The older idea is based on an unjustified analogy with terrestrial cyclones. A spot is, instead, an island of tranquility in a stormy sea. Indeed, because the sunspot area does not transport its share of the internal solar energy, we expect to find increased convection in the areas immediately outside the spot. And that is why sunspot regions are more active than others.

Under this conical dome are housed the 15-inch chromosphere camera and the 16-inch coronagraph. The Sacramento Peak Observatory is one of the branches of the Geophysics Research Directorate, Air Force Cambridge Research Center.

The convective flow deep down in the solar atmosphere consists of gases moving at speeds less than that of sound. As Dr. Krook has noted, however, a bubble of gas rising into regions of lower and lower density may increase its rate of flow to faster than sound. The supersonic flow develops into a shock wave that carries both matter and energy into the coronal regions. Such activity is largely responsible for the solar corona. In fact, gases are driven so far from the sun that our earth in a sense lies within the boundaries of the extended solar atmosphere. The interplay of this ionized gas and the earth's magnetic field are responsible for such phenomena as magnetic and ionospheric storms.

The kinetic energy of the shock waves dissipates into heat, so the corona attains temperatures ranging from one to five million degrees. The hottest areas are found near active sunspots.

Streamers of the solar corona show evidence of magnetic focusing. Active centers underlie each "petal," whose internal structure suggests the complex pattern of some vibrating medium. The imbedded magnetic field imparts to the gas some degree of rigidity, so that the whiplike oscillations have a simple theoretical explanation.

This bright prominence of the funnel type was recorded with the 15-inch chromosphere camera on September 28, 1956.

To calculate the motions of ionized gases (like prominence material) in gravitational and electromagnetic fields, the astrophysicist uses the magnetohydrodynamic equations of motion. These equations have several steady-state solutions, in which the various forces counterbalance one another. I have distinguished several types. There are pressure-balanced systems, wherein the electric currents tend to contract the system against the expansion of gas pressure. Of these we have two basic varieties. In the first or *poloidal* type the electric currents flow in a doughnut-shaped ring, with the magnetic field also a ring encircling the current. In the second or *toroidal* type, the field lies along the doughnut ring, with the currents at right angles. Toroidal fields tend to be less dense than the surrounding medium and thus will rise like a balloon to the surface. Conversely, poloidal fields are denser and will sink.

Next we find motion-balanced systems, where the forces derived from the moving gas are to be considered. The motion is usually along the magnetic lines of force. However, under some circumstances, as when an electric field can occur, material can flow across the magnetic field.

The basic theory can account, qualitatively and quantitatively, for the form and motion of many types of prominences. Further study is needed to explain why

(Continued on page 476)

The Origin of Planetary Nebulae

OTTO STRUVE, *Leuschner Observatory, University of California*

ASTRONOMERS currently have a keen interest in planetary nebulae. Some recent studies, both observational and theoretical, were outlined in my articles in the March and April issues.

There it was noted that these greenish bubbles of gas surrounding hot but faint stars are rapidly expanding, their lifetimes from birth to dissolution being only some tens of thousands of years. But before much can be said about the origin of these rapidly evolving objects, we must have some accurate information on their distances, in order to know the scale of the processes at work in them.

About 25 years ago at Mount Wilson Observatory, A. van Maanen measured the trigonometric parallaxes of 27 planetary nebulae. Only for one object, the giant planetary NGC 7293 in Aquarius (pictured on page 208 in March), was the resulting parallax appreciably greater than its probable error. The value was 0.038 ± 0.008 second of arc, meaning that there was a 50-50 chance the distance of NGC 7293 lay within the limits 71 and 109 light-years. The other planetaries turned out to be too remote for the trigonometric method to give meaningful distances.

However, van Maanen was able to compute a more reliable value for the *average* distance of 21 planetaries, by combining his own measurements of the proper motions of their central stars with their radial velocities as determined mostly at Lick Observatory. The result was about 1,400 parsecs (4,600 light-years). Evidently, the planetary nebulae are rather distant, and only NGC 7293 seems to be near enough for its distance to be measured directly. Our knowledge of individual planetary-nebula distances is woefully inadequate.

Many attempts have been made to fill this gap. For example, in 1931 H. Zanstra found that the absolute magnitude of the central star of a planetary could be estimated theoretically as follows: Add +0.8 to 0.7 times the difference in apparent magnitude of the star and the nebula as a whole.

The apparent magnitude of NGC 7293 is +6.5, of its central star +13.3. The difference is +6.8, which multiplied by 0.7 gives +4.8. Thus, according to the Zanstra method, the absolute magnitude of the central star in NGC 7293 is +4.8 + 0.8, or +5.6. It is easy to calculate the distance from the formula relating this to absolute and apparent magnitude, $M - m = 5 - 5 \log D$. The result in this case is about 350 parsecs (about 1,140 light-years), more than 10 times van Maanen's direct measurement of the distance.

Other astronomers have followed Zanstra's procedure more or less closely. In 1937 Louis Berman published a list of the individual distances of 136 planetaries, which has been extensively used by later workers. His value for NGC 7293 was 1,050 parsecs. On the other hand, a year later G. L. Camm found this distance to be only 75 parsecs. Finally, B. A. Vorontsov-Velyaminov has published two distance determinations of NGC 7293: 180 and 290 parsecs. Equally disconcerting results have been announced by these same astronomers for some other planetaries.

Which of the various NGC 7293 distance estimates appears most reasonable? Van Maanen's trigonometric parallax corresponds to 26 parsecs. At this distance the angular radius of the nebula, about seven minutes of arc, implies a linear radius of about 1/20 parsec or 1.6×10^{17} centimeters. The total volume of the nebula, considered as a sphere, would then be 2×10^{52} cubic centimeters.

The planetary consists almost entirely of hydrogen, which is certainly highly ionized, the protons and electrons being separated from each other and having equal numbers. Other studies, especially by L. H. Aller, indicate that there are about 10^3 electrons per cubic centimeter. Hence, the total number of electrons in NGC 7293 is about 2×10^{55}, and this is also the number of protons.

Each proton has a mass of 1.7×10^{-24} gram, while that of an electron is negligible in comparison. Therefore, the mass of the entire nebula is $1.7 \times 10^{-24} \times 2 \times 10^{55}$, which is 3.4×10^{31} grams. This is about 1/60 the sun's mass, provided that van Maanen's distance of 26 parsecs is correct. The result is consistent with our belief that the upper limit for mass of a typical planetary is about 1/10 that of the sun. Were we to carry out a similar calculation using Berman's distance estimate of over 1,000 parsecs, the planetary would have to have enormous dimensions and an improbably great mass.

These and similar considerations led I. S. Shklovsky, in the *Russian Astronomical Journal*, to propose a new method for determining the distances of individual planetaries. It applies only to those that are optically thin, containing too little gas to dim appreciably other objects shining through them. This is true for most planetaries, and certainly for all the large ones of relatively low surface brightness. It is probably not the case for the tiny starlike objects of high surface brightness, which are especially numerous in the central bulge of the Milky Way.

Shklovsky reasons that the amount of light produced by each cubic centimeter of the nebula must be proportional to the number of protons and also to the number of free electrons, these numbers being equal, as we have seen. From this he deduces that the surface brightness is proportional to the square of the total mass divided by the fifth power of the linear radius, that is, to M^2/r^5.

If the distance of the nebula is D and its angular radius is s, then the linear radius is proportional to Ds, and we may express the surface brightness, I, as proportional to M^2/D^5s^5.

Next, Shklovsky suggests as a good approximation that we assume the masses of all planetaries are the same. This makes M a constant in the relation:

$$D \sim M^{2/5}/sI^{1/5}.$$

We do not know the mass beforehand, but we do know that the average distance of the 21 planetaries for which van Maanen measured proper motions is 1,400 parsecs. If the angular diameters and surface brightnesses have been observed for these nebulae individually, then we can compute their average mass. The result is about 0.1 solar mass, in agreement with the value used in our earlier discussions. With this value of M, we can then compute the distances of all those optically thin nebulae for which s and I have been listed.

There seems little doubt that the distances Shklovsky found by this method are much better than any earlier ones. For NGC 7293 he finds 50 parsecs, in reasonably good agreement with van Maanen's direct measurements. The Ring nebula in Lyra (NGC 6720) turns out to be 390 parsecs, matching well the value of 430 parsecs derived from the rate of expansion of this object. Only for the few optically thick planetaries does Shklovsky's

method break down, and he gives the upper limits to their distances.

Of course, it is hardly likely that all planetaries actually do have identical masses. But the distance depends only upon the 2/5 power of the mass in Shklovsky's formula, and a tenfold error in the adopted mass would cause only a 50-percent error in the distance.

The Russian astronomer has used his distance determinations to draw some interesting conclusions. He could estimate the density of the planetaries in space, finding the total number of these objects in our galaxy to be 60,000. In March, on page 211, we discussed G. A. Gurzadian's result that the lifetime of a planetary is of the order of 20,000 years. Hence, to maintain a uniform population of 60,000, about three new planetaries are somehow produced each year, and three old ones diffuse away. Shklovsky thinks this disintegration process may actually maintain the total mass of the gaseous substratum of the Milky Way.

Once we know the distance of a planetary nebula, we can compute the absolute magnitude of its central star directly from its apparent brightness. For example, we have noted that the central star of NGC 7293 has an apparent magnitude of +13.3; since it is 50 parsecs from us, according to Shklovsky, the absolute magnitude is +9.8. Other planetaries have much brighter central stars—absolute magnitude 0 for NGC 2392 and NGC 6578. Shklovsky concludes that, while planetary nebulae are all of approximately the same mass, their central stars have a very large range in absolute magnitude, between about −1 and +10. These central stars are all very hot, with surface temperatures between 30,000° and 100,000° absolute, and it is important that we learn more of their nature.

Consider the central star of NGC 7293. In surface temperature it resembles an *O*-type star, whose absolute magnitude may be about −4. Both stars therefore emit about the same amount of energy per unit surface area. But the nucleus of NGC 7293 has an absolute magnitude of +9.8, making it 13.8 magnitudes fainter than an ordinary *O* star—a light ratio of 1 to about 330,000. Hence the central star of NGC 7293 must be much smaller than a normal *O* star, with only about 1/600 of its radius, or about 1/60 of the sun's radius.

While the masses of the central stars are not known, a reasonable guess is that they contain about as much material as the sun. If so, then the mean density of the central star of NGC 7293 comes out 300,000 grams per cubic centimeter! Even if we have overestimated somewhat the mass or surface temperature of this star, it is still extremely probable that it resembles a white dwarf.

Shklovsky believes that as a planetary nebula evolves from a tiny starlike object to a large, turbulent gas shell of low surface brightness, the central nucleus also is changing from a fairly luminous hot *O*-type or Wolf-Rayet star to an exceedingly hot and faint white dwarf. If so, about three such degenerate stars are produced each year from planetaries, and in one billion years some 3×10^9 white dwarfs will have been added to our galaxy. Since this is close to the estimated total number of white dwarfs, it is not unreasonable to believe that all white dwarf stars are the descendants of former planetaries.

But what of the ancestors of the planetaries? These nebulae are expanding, and in their earliest stages they are small and dense, with high surface brightnesses. Such primitive nebulae are optically thick; they are opaque to the light of their central stars, and their outermost layers are essentially cold hydrogen gas. (This gas is neutral hydrogen because the ionizing ultraviolet radiation of the central stars does not reach it.)

According to Shklovsky's estimate, such a very young planetary may have only 1/100 or 1/1,000 the radius of an old nebula like NGC 7293. The density of the primitive nebula would be about 10^9 to 10^{12} hydrogen atoms per cubic centimeter, and the temperature of the outer layers about 1,000°.

These properties are like those of the outer parts of the extended, relatively cool atmospheres of the largest red supergiant stars, whose photospheres may be about 100 to 1,000 the sun's diameter, and whose tenuous atmospheres may extend 10 or more times farther out.

The comparison is not spoiled by the fact that inside a young planetary there must be a very hot and small nucleus; all modern ideas on the evolution of red supergiant stars demand that they have just such nuclei.

Red supergiant stars that could qualify as the ancestors of planetary nebulae must meet two rather stringent conditions. First, their distribution in space and their space motions must resemble those of the planetaries and the white dwarfs. Also, the stars must not be excessively massive; the loss of mass during the planetary-nebula stage can hardly be much greater than the normal observed mass of the nebula itself—say 0.1 solar mass.

Shklovsky suggests that the RV Tauri variable stars (among other groups) may satisfy these conditions. Their distribution in space fits the hypothesis, and, while their masses are not known, their radii and absolute magnitudes agree roughly with those of the youngest planetaries.

According to M. Schwarzschild and others who have worked on the theoretical problem of stellar evolution, a red giant represents a stage in the development of a star of moderate mass, in which the inner core is essentially devoid of hydrogen, consisting mainly of helium. This core contracts gravitationally at a fairly rapid rate. The resulting heating of the core affects the outer layers of the star and may, according to Shklovsky, trigger the observed expansion of the planetaries.

ARTHUR S. KING DIES

Since the early days of Mount Wilson Observatory, it has operated a physics laboratory whose main purpose has been experimental study of spectra to aid interpretation of astronomical spectra. Arthur S. King became head of this laboratory in 1908, five years after he received the first Ph.D. in physics awarded by the University of California in Berkeley. He held this position until 1943.

During his 35 years on the Mount Wilson staff, Dr. King built and used a high-temperature furnace for studies of lines appearing in the solar spectrum, and did important work on meteorites, the classification of spectral lines, and the spectra of rare-earth elements. He was the discoverer of the isotope carbon 13.

After retirement, Dr. King continued to work at the California Institute of Technology, and served as a mathematician with the Naval Ordnance Test Station in Pasadena until 1954. He died on April 25, 1957, at the age of 81.

One of the bright planetary nebulae of southern skies is NGC 3132, here seen in a photograph made with the 60-inch reflector at the Boyden station in South Africa. It is sometimes known as the "eight-burst planetary," and has an apparent photographic magnitude of about 8.2, while the central star is 10.6. Located on the border of Antlia and Vela, NGC 3132 has apparent dimensions of about 84 by 53 seconds of arc. Harvard Observatory photograph.

THE FIFTY BRIGHTEST STARS

Harold L. Johnson, *Lowell Observatory*

Many lists of the brightest stars have been made. None, however, has had the advantage of being based upon accurate photoelectric observations. Inasmuch as such determinations of bright stars have now become available, a new list, containing the 50 brightest stars, is presented here.

The columns give the number in order of brightness; the Bayer letter designation; the star's proper name, if any; and then its spectral type and luminosity class on the MKK (Morgan-Keenan-Kellman) system; the apparent visual magnitude **V**; the color index **B−V**; and the blue magnitude **B**.

An asterisk following the magnitude of a star indicates that it is a visual binary whose separation is too small to be noticed by the unaided eye; in these cases the combined magnitudes and colors are given. Stars marked with a dagger vary in light, their ranges being given in the footnote. Two variable stars of large range, Omicron Ceti (Mira) and Eta Carinae, which are sometimes brighter than 2nd magnitude at maximum light, are omitted from the table.

The probable errors of the magnitudes, **V**, are approximately ±.015 to ±.020 magnitude. Therefore, the order of the 10 brightest stars in the list is very unlikely to be changed by additional observations; even among the 20 brightest stars the order is probably not significantly in error. For the faintest stars in the list, however, observational errors may change the order of brightness. In fact, some of those at the very foot of the list may not actually belong among the first 50, while other stars should perhaps have been included instead.

The magnitudes and colors of the northern stars are all from photoelectric observations, mostly from the published data of Johnson and Morgan (*Astrophysical Journal, 117*, 313, 1953), and Johnson and Harris (*Astrophysical Journal, 120*, 196, 1954), and from unpublished observations by these authors. The magnitudes and colors of the southern stars depend primarily upon the photoelectric and photographic observations taken at the Royal Observatory, Cape of Good Hope, South Africa (*Cape Mimeogram* No. 1). Southern observations by Eggen (*Astronomical Journal, 60*, 65, 1955) were included but were given lower weight.

It has been necessary, of course, to transform the observations of the Cape Observatory and of Eggen to the B, V system, since they were published in other systems. These transformations were determined from stars, mostly not among the 50 brightest, that are common to the several catalogues. In some cases, these transformations are not strictly linear, and compensation had to be made for the nonlinearity.

The visual magnitudes, **V**, are on the system of the International photovisual magnitudes of the north polar sequence. They average about 0.1 magnitude brighter than the magnitudes of the *Henry Draper Catalogue*. The color indices, **B−V**, represent the International color indices about as well as the International colors are defined. In accord with the original definition of the International system, the zero point of the color indices is placed at *A*0 V, while **B−V** is +1.00 at *K*0 III. The blue magnitudes, **B**, contain no ultraviolet short of 3800 angstroms, approximately, in order to minimize the difficulties of transformation from one similar system to another, and may be considered to be "photographic" magnitudes.

	Bayer Designation	*Name*	*Spectrum*	**V**	**B−V**	**B**
1	α Canis Majoris	Sirius	*A*1 V	−1.43	+0.00	−1.43
2	α Carinae	Canopus	*F*0 Ia	−0.73	+0.15	−0.58
3	α Centauri	(Alpha Centauri)	*G*2 V	−0.27*	+0.66	+0.39*
4	α Bootis	Arcturus	*K*2 IIIp	−0.06	+1.23	+1.17
5	α Lyrae	Vega	*A*0 V	+0.04	+0.00	+0.04
6	α Aurigae	Capella	(*G*0)	+0.09	+0.80	+0.89
7	β Orionis	Rigel	*B*8 Ia	+0.15	−0.04	+0.11
8	α Canis Minoris	Procyon	*F*5 IV-V	+0.37	+0.41	+0.78
9	α Eridani	Achernar	*B*3 V	+0.53	−0.16	+0.37
10	β Centauri	(Beta Centauri)	*B*0.5 V	+0.66*	−0.21	+0.45*
11	α Orionis	Betelgeuse	*M*2 Iab	+0.7†	+1.87	+2.6†
12	α Aquilae	Altair	*A*7 IV, V	+0.80	+0.22	+1.02
13	α Tauri	Aldebaran	*K*5 III	+0.85†	+1.52	+2.37†
14	α Crucis	(Alpha Crucis)	*B*0.5 V	+0.87*	−0.24	+0.63*
15	α Scorpii	Antares	*M*1 Ib	+0.98*†	+1.80	+2.78*†
16	α Virginis	Spica	*B*1 V	+1.00	−0.23	+0.77
17	α Piscis Austrini	Fomalhaut	*A*3 V	+1.16	+0.09	+1.25
18	β Geminorum	Pollux	*K*0 III	+1.16	+1.01	+2.17
19	α Cygni	Deneb	*A*2 Ia	+1.26	+0.09	+1.35
20	β Crucis	(Beta Crucis)	*B*0.5 IV	+1.31	−0.23	+1.08
21	α Leonis	Regulus	*B*7 V	+1.36	−0.11	+1.25
22	ε Canis Majoris	Adhara	*B*2 II	+1.49	−0.17	+1.32
23	α Geminorum	Castor	(*A*0)	+1.59*	+0.05	+1.63*
24	λ Scorpii	Shaula	*B*2 IV	+1.62	−0.23	+1.39
25	γ Orionis	Bellatrix	*B*2 III	+1.64	−0.23	+1.41
26	β Tauri	Elnath	*B*7 III	+1.65	−0.13	+1.52
27	β Carinae	Miaplacidus	*A*0 III	+1.65	+0.00	+1.65
28	γ Crucis	(Gamma Crucis)	*M*3 II	+1.67	+1.53	+3.20
29	ε Orionis	Alnilam	*B*0 Ia	+1.70	−0.18	+1.52
30	α Gruis	(Alpha Gruis)	*B*6 V	+1.75	−0.14	+1.61
31	ζ Orionis	Alnitak	*O*9.5 Ib	+1.78*	−0.21	+1.57*
32	ε Ursae Majoris	Alioth	(*A*0p)	+1.78	−0.02	+1.76
33	γ Velorum	(Gamma Velorum)	*WC*7+*B*3	+1.80*	−0.24	+1.56*
34	α Persei	Mirfak	*F*5 Ib	+1.80	+0.48	+2.28
35	α Ursae Majoris	Dubhe	*K*0 III	+1.80	+1.06	+2.86
36	ε Sagittarii	Kaus Australis	*B*9 IV	+1.82	−0.04	+1.78
37	δ Canis Majoris	Wezen	*F*8 Ia	+1.84	+0.66	+2.50
38	η Ursae Majoris	Alkaid	*B*3 V	+1.87	−0.20	+1.67
39	θ Scorpii	(Theta Scorpii)	*F*0 I-II	+1.87	+0.37	+2.24
40	β Aurigae	Menkalinan	(*A*0p)	+1.90	+0.03	+1.93
41	δ Velorum	(Delta Velorum)	*A*2 V	+1.92*	+0.03	+1.95*
42	γ Geminorum	Alhena	*A*0 IV	+1.93	+0.00	+1.93
43	α Trianguli Australis	(Alpha Tri. Aus.)	(*K*2)	+1.93	+1.41	+3.34
44	α Pavonis	(Alpha Pavonis)	*B*2 V	+1.96	−0.20	+1.76
45	β Canis Majoris	Murzim	*B*1 II-III	+1.97	−0.23	+1.74
46	ε Carinae	(Epsilon Carinae)	*K*0+*B*	+1.97	+1.13	+3.10
47	α Hydrae	Alphard	*K*3 III	+1.98	+1.44	+3.42
48	α Arietis	Hamal	*K*2 III	+2.00	+1.15	+3.15
49	α Ursae Minoris	Polaris	(*F*8)	+2.01†	+0.60	+2.61†
50	β Ursae Minoris	Kochab	*K*4 III	+2.02	+1.47	+3.49

*Visual double star with brightness difference less than five magnitudes; the magnitude given is for both components measured together.

†Variable star with range of **V**: Betelgeuse, 0.4 to 1.0; Aldebaran, 0.75 to 0.95; Antares, 0.90 to 1.06; Polaris, 1.96 to 2.05.

Spectra in parentheses are from the *Henry Draper Catalogue*.

AMERICAN ASTRONOMERS REPORT

Here are highlights of some papers presented at the 97th meeting of the American Astronomical Society at Cambridge, Massachusetts, in May. Complete abstracts will appear in the Astronomical Journal.

Space-Travel Panel

Eleven hundred persons attended a public meeting in Harvard's Sanders theater on the evening of May 9th, organized by the educational committee of the American Astronomical Society and by Harvard and Smithsonian Astrophysical observatories. Four astronomers gave their views on space travel, with J. M. Chamberlain, Hayden Planetarium, chairman of the committee, acting as moderator.

A prediction that by 1970 man will have circled the earth in an early type of spaceship was ventured by the first speaker, F. L. Whipple, director of the Smithsonian Astrophysical Observatory. It might be sooner than 13 years if there is a united effort to that goal, as no new scientific breakthroughs are needed.

In this connection, another panel speaker, J. W. Ciry, of Project Vanguard, pointed out that it will take a vehicle 72 feet tall, weighing over 25 tons, to place the artificial satellite in its orbit. If we wanted to have a satellite 10 times as heavy (about 200 pounds), the weight of the projectile and its fuel would have to be increased by this same factor. Nevertheless, these speakers agreed that this seemingly formidable requirement can be solved.

To go from the 18,000-miles-per-hour speed of a satellite of the earth into an orbit that would reach the moon, a 40-per-cent increase in velocity must be achieved. Dr. Whipple said that nuclear fuels look very promising, because a great deal of energy can be packed into a small space. Nuclear fuels are at present too quick, as in atomic bombs, or too slow, but harnessing them into an intermediate rate of energy production may soon be achieved (see page 482).

Next is the problem of the environment of the ship as a place to live. Sounding rockets have procured much information on the hazards from radiation and particles in space. Ultraviolet light may be easily prevented from entering a spaceship, and X-rays are no problem either. Corpuscular matter from the sun may etch away the outer surface of a vehicle, but only very slowly. Even meteoric pitting would be slight—an optical surface exposed for a year would probably not show an appreciable effect. As for sizable meteoroids, some years ago Dr. Whipple proposed a meteorite bumper—a second outside skin on the spaceship to capture any dangerous particles.

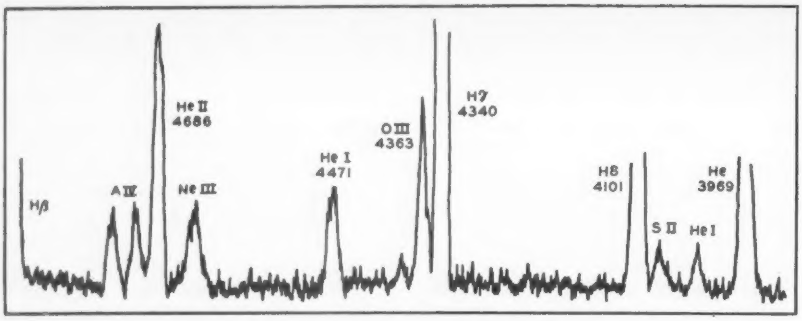
The most important problem for a manned vehicle is the human one. Air supply, proper temperature, and elimination of wastes are but a few of the factors that require further study. Because of this, robot-controlled spacecraft have been proposed, but Dr. Whipple thinks the cost of such developments will be too great and that man will be traveling in space before robots can be perfected.

G. M. Clemence, director of the U. S. Nautical Almanac Office, considered (unofficially) the problem of tracking ships in space, which he defined for discussion purposes as that region of the solar system between the orbits of Venus and Mars, excluding the immediate vicinity of the earth. There are basically two ways of tracking—from the earth and from the ship itself. The astronomical methods long used in observing comets and planets are the same as will be employed in keeping track of spaceships from the earth. Although much smaller than a planet, a spacecraft will probably reflect enough sunlight to be observed through terrestrial telescopes. As a ship moves beyond observing range, however, it will have to find its own position, using the time-tested navigational methods of mariners.

Dr. Clemence personally prefers machines to men as observers on a spaceship. He pointed out that it is very costly to equip man for space flight, for each person needs up to a ton of auxiliary material for every day he is away from the earth—this tremendous weight might better be used for instruments.

The importance of an observing station in space was cited by Dr. Ciry, who outlined some of the astronomical advantages

At the panel on space travel, Dr. G. M. Clemence is speaking, and the chairman, J. M. Chamberlain, is seated at the right. Other speakers, left to right at the table, are Drs. F. L. Whipple, G. de Vaucouleurs, and J. W. Ciry. The nose cone of an Aerobee rocket is at the right. Photograph by Robert E. Cox.



The peaks along this intensity tracing indicate the bright lines in the spectrum of the planetary nebula NGC 7009, from photoelectric observations by Michigan astronomers with the 100-inch Hooker reflector on August 31, 1956. Some of the brighter lines were so intense that the recording pen ran off scale. The scanner slot width was 12 angstroms, and the scanning speed 90 angstroms per minute. In this representation of the blue portion of the spectrum, longer wave lengths are toward the left. University of Michigan Observatory diagram.

that even small instruments in a satellite can provide. From the practical standpoint, he mentioned the instance of photographs of the earth taken with an Aerobee rocket launched at White Sands Proving Ground a short time ago. By piecing together almost 100 pictures taken from a height of about 60 miles, meteorologists found an enormous cyclonic circulation in the atmosphere that had completely escaped ground-based observers. A later check of the records showed the reality of the pattern of air flow, but the rocket had seen it "in a matter of a few minutes."

Observing the planets Venus and Mars at close range from a spaceship was discussed by G. de Vaucouleurs, Lowell Observatory. Care would have to be taken in traveling to Venus, for higher temperatures would prevail so much nearer to the sun. Observing projects would seek to measure the depth of Venus' cloud-filled atmosphere, the nature of the clouds, and the mass of the planet. Because Venus has no moon of its own by which a mass determination can be made, the spaceship might be allowed temporarily to become a satellite—the orbit it followed would provide the required data.

Observations of this same type could be made from a ship encircling Mars. There is a fairly large discrepancy between the observed polar flattening (oblateness) of Mars and the internal distribution of mass as indicated by the motions of its satellites. But a spaceship would probably have to remain about 1,000 miles above the planet's surface, to avoid encountering the resistance of its atmosphere, which thins out more slowly at great heights than does the earth's air.

From a 1,000-mile height, with a 10-inch telescope, markings as small as 100 feet in diameter should be visible on the surface of Mars. We ought to be able to determine whether or not the canals exist and detect any volcanic activity.

Dr. de Vaucouleurs proposed observations of the sun's spectrum, to be made by spaceship observers with the sun on the horizon to give a very long path through the Martian atmosphere. This could increase the sensitivity of our present spectroscopic studies of the planet's atmosphere by a factor of about 20 to 1, compared with observations made from the surface of the earth.

Spectrophotometry of Planetary Nebulae

During the late summer and early autumn of 1956, with the 60- and 100-inch reflectors at Mount Wilson Observatory, William Liller and Lawrence H. Aller, University of Michigan Observatory, carried out measurements of line intensities in the spectra of 26 planetary nebulae, covering the wave-length range from 3200 angstroms in the ultraviolet to 12,000 in the infrared.

The spectra were produced by a reflection grating having 600 lines per millimeter, with identical f/5 Newtonian systems used as the collimating and focusing units. By rotating the grating, the spectrum of each nebula could be scanned either with a blue-sensitive or a red- and infrared-sensitive photomultiplier. The two photocells made it possible to sweep the spectra over the range mentioned above. At the wave length of the hydrogen-alpha line, both cells were just about equally efficient.

The 26 planetaries included most of the nebulae studied photographically by Dr. Aller some years ago. For the brighter ones, such as NGC 7009, as many as 35 emission lines were recorded, ranging from the Ne V line at 3425 angstroms to the Paschen-gamma line at 10,938. But in the faintest planetary nebula observed, the one in the globular cluster M15, only three lines were recorded.

With these observations Drs. Liller and Aller plan to derive improved values of the electron temperatures and densities of planetary nebulae. Combining this with other work, they may be able to clarify the differences in chemical composition between these objects of Population II and stars of Population I.

Width of Meteor Trails

In an attempt to find the true diameter of the column of luminous gas surrounding a falling meteoric body, three Harvard and Smithsonian astronomers have studied the trails of 104 meteors appearing on the original plates of the National Geographic-Palomar Observatory Sky Survey. These photographs were taken with the Palomar 48-inch Schmidt telescope, whose theoretical resolving power is sufficient to distinguish two lines separated by four centimeters at a distance of 100 kilometers. On actual photographs, however, resolution is poorer than this because of atmospheric turbulence and the grain of the photographic emulsion.

In this work by G. S. Hawkins, Cecilia Payne-Gaposchkin, and F. L. Whipple, the widths of the meteor images were measured and compared with the widths of star images of similar intensity. The differences could be interpreted as meteor trail widths, after certain small corrections were applied. One correction allowed for the fact that since the Schmidt camera is focused for infinity, a meteor at such a distance as 150 kilometers would appear slightly out of focus. For the 51 meteors of average magnitude +3 whose distances could be estimated with some reliability, the final result was 1.3 meters for the diameter of the luminous column.

This is a considerable departure from earlier views that the diameter of a meteor trail is of the order of a centimeter. While the measurements were delicate, the new result is believed by its authors to be no exaggeration, since elimination of systematic errors tends to increase the measured trail widths.

Satellite Lifetime

The length of time that an artificial satellite of the earth will remain in the sky depends to a great degree upon the density of the atmosphere through which it is moving. Previously, the density up to 335 miles above the earth's surface had been known from U. S. Air Force calculations extending the model known as the United States standard atmosphere.

This model has now been extrapolated to even greater heights by Theodore E. Sterne, of the Harvard and Smithsonian Astrophysical observatories. He suggests that it be used in inferring the actual density of the upper air from observations of the artificial satellite, and he has derived convenient equations for this purpose. Calculations of only slide-rule accuracy enable rather precise corrections to be made to the predicted density near perigee, from observations of the satellite's changing apogee distance.

If the Air Force atmospheric model as extended by Dr. Sterne is approximately correct, a 50-centimeter, 10-kilogram spherical earth satellite with a perigee height of 200 miles and an apogee height of about 800 miles should be expected to have a lifetime of about nine years.

Cataloguer of the Stars

FRANCIS P. SCOTT, *U. S. Naval Observatory*

HERBERT ROLLO MORGAN died at his home in Washington, District of Columbia, on June 11, 1957, after a two-month illness. Born March 21, 1875, on a farm near Medford, Minnesota, he moved at the age of nine to Tennessee.

His early education was obtained in a Tennessee country school, when his affliction with asthma permitted him to attend. What was missed at school was supplied by home study under the guidance of his mother. When he entered his teens, he had definitely decided that astronomy and mathematics were his chief interests.

After a single year at the nearby University of Virginia, he became the sole support of his aging mother, and had to withdraw. But he had become acquainted with Ormond Stone, director of the university's Leander McCormick Observatory. Professor Stone took a particular liking to him and, perhaps more than anyone else, influenced him and directed his studies into the field of classical astronomy. With the aid of a Vanderbilt fellowship at the observatory, Morgan resumed his studies in 1896, receiving his B.A. degree in 1899 and his Ph.D. in 1901.

While at Virginia, he published a number of papers dealing mostly with the orbits of comets and satellites. Seen in retrospect, this early work showed a latent ability that later grew and earned for him recognition as a master in the art of analyzing observations.

On leaving the university, he accepted a position as a computer at the Naval Observatory, where he met and married Fannie E. Wallis, who with their daughter, Mrs. George Hoffman, survives him. After four years of computing, he became professor of astronomy and mathematics at the Morrison Observatory, in Glasgow, Missouri.

But in 1907 he returned for good to the Naval Observatory, as an assistant astronomer on the staff of the 9-inch transit circle. There his scientific stature grew very rapidly, and he was placed in charge of the instrument in 1913.

His first program with the 9-inch consisted of fundamental observations of the sun, moon, planets, standard and intermediary stars. The resulting catalogue, commonly known as W20, is a classic example of the thoroughness of all Dr. Morgan's work. His next observing project was a differential determination of the positions of reference stars to be used in the reduction of the Yale photographic observations of stars in the declination zone $-10°$ to $-20°$. This work was followed by a fundamental program extending from 1935 to his retirement from the observatory in 1944.

About 1920, after the W20 program was well under way, Dr. Morgan began to find time for the discussion of observations, first his own, and later those of others. Each succeeding analysis took him deeper into the problems of fundamental astronomy. A long series of papers, published both before and after his retirement, deals with the constants of nutation and aberration, the motion of the equinox, secular variations of the elements of planetary orbits, and a host of similar topics. These publications reveal his deep understanding of the problems of fundamental astronomy and his remarkable skill in the discussion of observations.

After retirement, he continued his investigations privately for a while, and later, from 1947 to 1950, as a research associate of Yale University. It was during this period that he produced his N30 catalogue, which astronomers regard as one of his most important works.

H. R. Morgan is shown observing with the 9-inch transit circle of the U. S. Naval Observatory. He was a master of the difficult art of determining fundamental positions and motions of the stars.

In preparing the N30, Dr. Morgan introduced a new technique which departed considerably from traditional methods. He was of the opinion that the *average* of the positions of a star given by the old catalogues represented all the information that could be obtained from them, and he objected seriously to deriving proper motions from individual old catalogues, believing that their unknown systematic errors would vitiate the results. He accordingly adopted the positions of the Boss *General Catalogue* (GC) at its mean epoch and, after applying certain well-known corrections, compared them with normal positions having a mean epoch about 1930, derived from all the fundamentally observed catalogues accumulated since the compilation of the GC. This unconventional procedure brought both praise and criticism. Perhaps only time and the tests of future astronomers will be able to evaluate the wisdom of his method.

At any rate, the N30 is at present the most accurate source of positions and proper motions available to astronomers. This is evidenced by the great variety of studies in which the N30 proper motions have been used for problems involving an interplay of astrometric and astrophysical data. They have led, among other things, to a better knowledge of the precession, the constants of galactic rotation, and the luminosities of the nearby Cepheids.

The success of the N30 proper motions in recent studies created such a demand for the extension of the N30 system to include special groups of stars that, up to the time of his last illness, Dr. Morgan was busily engaged in computing the motions of several hundred *O*- and *B*-type stars.

From 1940 to 1942, Dr. Morgan was vice-president of the American Astronomical Society. He also served as the president of the commission on meridian astronomy of the International Astronomical Union from 1938 to 1948, and as associate editor of the *Astronomical Journal* from 1942 to 1948. His greatest honor came in 1952, when the National Academy of Sciences bestowed upon him the Watson medal for his achievements in fundamental astronomy.

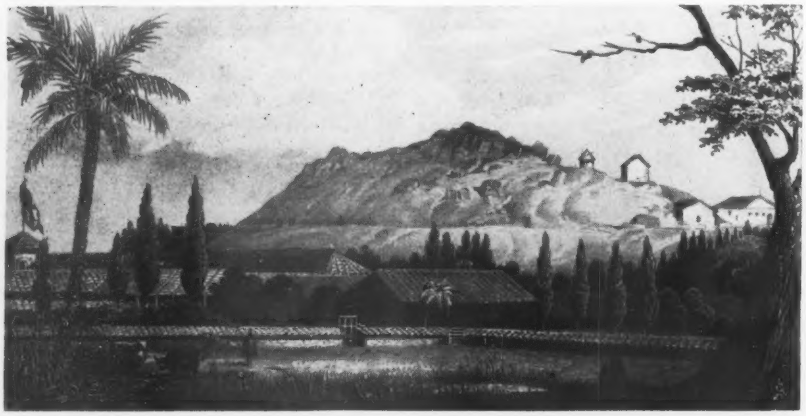
A model of the new buildings and grounds of the National Astronomical Observatory of the University of Chile, now being built on the western slopes of the Andes Mountains. The main building faces a road leading toward a family housing area. The smaller units will contain a visual Heyde refractor, Gautier astrograph, Bamberg broken transit, Repsold meridian circle, and the 24-inch Grubb refractor. The architects of the observatory are Enrique Marchetti and Isidoro Latt. All photographs with this article are by Jorge Barrera.

Chile's New National Astronomical Observatory

FEDERICO RUTLLANT, *National Astronomical Observatory, University of Chile*

AT SANTIAGO, in Chile, the National Astronomical Observatory will soon move to an improved location, the fourth one it has occupied in 108 years. The new site is at the top of a hill, Cerro Calán, some 2,800 feet above sea level, on the western slopes of the Andes Mountains and about nine miles northeast of the center of Santiago.

It was 1849 when Lt. James M. Gilliss, of the U. S. Navy, set up his telescopes on top of rocky Santa Lucia Hill (now in the middle of the city) and marveled at the clear dry air of the Andes. Formally transferred to the Chilean government upon Lt. Gilliss' departure in 1852, the observatory at Santiago is considered to be the first one permanently founded on the South American continent, although a short-lived observatory had been set up at Buenos Aires, Argentina, in 1822.

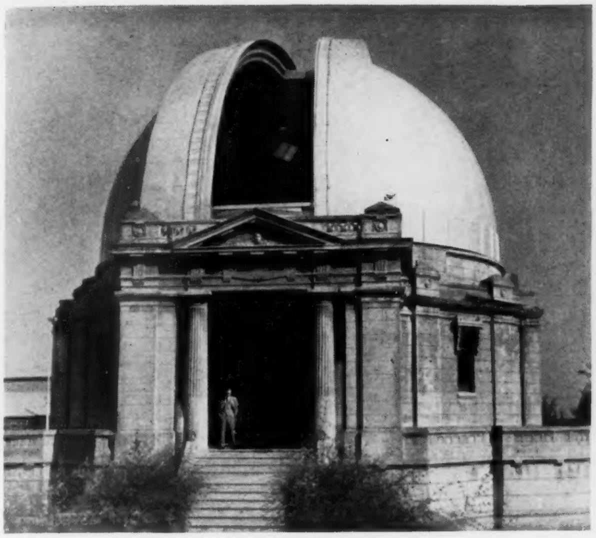


A drawing of Santa Lucia Hill in Santiago shows the first observatory in 1849. The small circular building closest to the summit sheltered the 6½-inch refractor, the rectangular one to its right the meridian circle. Prefabricated in Washington, D. C., by Lt. James M. Gilliss, the buildings were taken apart to be put in small packages and shipped around Cape Horn with the instruments, then reassembled on the observatory site. From "The U. S. Naval Astronomical Expedition to the Southern Hemisphere During the Years 1849-52," published in 1855.

The main purpose of the American naval expedition to Chile had been to determine the distance from the earth to the sun, by simultaneous observations of the planet Mars (and also Venus) from two widely separated geographical locations. When Lt. Gilliss undertook the plan, the best-equipped observatory in North America was at Cambridge, Massachusetts. By setting up a field station in Chile, he could secure a second observing point some 5,000 miles distant, on practically the same meridian of longitude as Cambridge.

A few years earlier he had been instrumental in founding the U. S. Naval Observatory. When he undertook the expedition to the Southern Hemisphere, he planned to study progress in science, agriculture, and commerce there, as well as to do astronomical work.

Travelers sailing on clipper ships around Cape Horn, bound from New York to California in the 1840's, had brought back exciting tales of the fertility and wealth of Chile, and of the hospitality



Left: The present dome of the 24-inch Grubb refractor at San Bernardo, south of Santiago. Standing in the entrance is Gabriel Raab, the Chilean engineer who restored this fine instrument to working condition in 1956.

Right: Construction on the new dome for the Grubb as it looked in February, 1957. The building, 45 feet in diameter, will have an electrically operated rising floor. The foothills of the Andes Mountains are seen in the distance.

of its inhabitants. The U. S. government had expressed interest in the newly independent country, which was striding toward self-government. The Chilean ambassador at Washington had urged that the Gilliss expedition assist his country in setting up an astronomical observatory.

After a three-month journey to Santiago, including a land crossing of Panama, Lt. Gilliss in December, 1849, set up a $6\frac{1}{2}$-inch refractor and a meridian circle. A professor of mathematics and two students of the National Institute worked with the American party. Of the favorable observing conditions in Santiago, the American astronomer wrote:

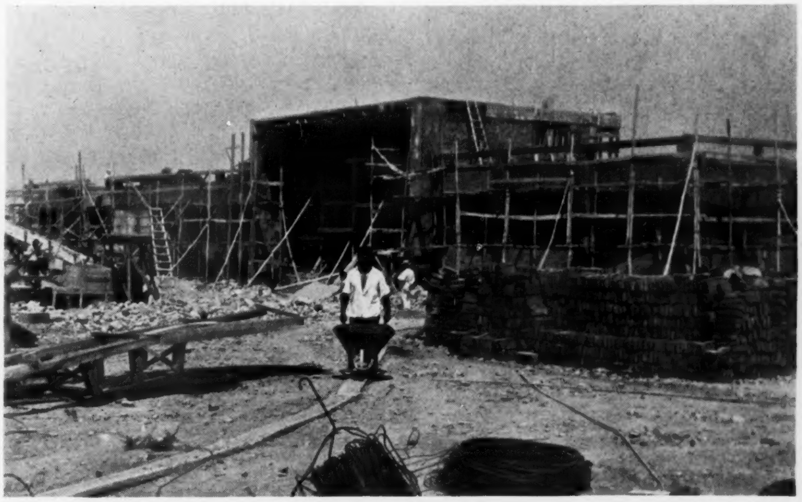
"It was a great satisfaction to work with an instrument like ours, but there was almost too much of it. Out of 132 consecutive nights after the equatorial was mounted, there were only seven cloudy ones! Of necessity, to afford so large a proportion, the air must be exceedingly destitute of moisture—a condition of things favorable to telescopic vision, but not so to eyes employed during prolonged observations. To persons accustomed, as we had been, to heat and moisture combined, the change proved, as had been intimated, exceedingly trying. . . . We had the satisfaction to accumulate from a previously unexplored, or almost unexplored field, an amount of astronomical data which has probably never been equalled within a similar period of time."

When Lt. Gilliss returned home, Dr. Charles Moesta became director of the observatory, and in 1857 it was moved to quarters in the Quinta Normal, the agricultural school of the university, on the outskirts of Santiago. In 1910, Director F. W. Ristenpart took it to its present site in San Bernardo, a small town about nine miles south of the city. Today, the expanding population and city lights, together with a need for more adequate buildings, have caused the move to Cerro Calán.

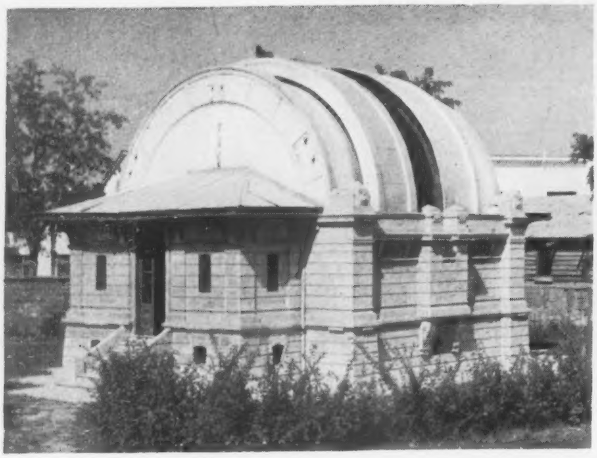
As part of the University of Chile, our observatory will be close enough to the city for student instruction, yet its new location 800 feet higher than the metropolitan area shields it from city lights and smoke. We enjoy more than 180 clear nights a year, with a temperature range of about 28° to 90° Fahrenheit. Our average rainfall is 14 inches, mostly between April and September, the southern fall and winter. The summers are rather dry, hot in the daytime and chilly at night.

Up to the present time, the Santiago observatory has done chiefly astrometric work, with emphasis on accurate positions of minor planets and comets. We are in charge of the national time service, and we make daily sunspot records, both visually and photographically. One night each week our buildings are open to the public. Since the 1890's, except for a few interruptions before 1930, we have annually published an almanac.

Larger buildings and more equipment will permit enlarging the scope of our activities. We plan a photometric program, as well as spectrographic observations with the 24-inch Grubb refractor, and later some solar physics and radio astronomy. The Hilger spectrograph can be



As construction progresses, the new main building takes form, its three stories to contain an auditorium, classrooms, a library, the director's quarters, offices, laboratories, workshops, and clock vaults, with a terrace for observing with portable instruments. The building is expected to be occupied in 1958.



At the left is the present building for the $7\frac{1}{2}$-inch Repsold meridian circle at San Bernardo. In its new structure on top of Cerro Calan, pictured on the right, this instrument will be aligned on the same meridian as the nearby Bamberg broken transit, for collimation purposes.

used with either two-prism or four-prism optical trains. The dome housing the Grubb telescope is 45 feet in diameter, with an electrically operated rising floor.

Construction at the new site began in 1956, at a projected cost of $340,000, not including instruments, and is scheduled for occupancy by 1958. The new main building will contain the administrative quarters, offices for the scientific staff, classrooms, a 6,000-volume astronomical library, and a 100-seat auditorium. There will also be photographic, optical, and electronics laboratories, as well as machine and woodworking shops. Also planned are a small cafeteria and other conveniences.

The director will have his residence in a wing of the main building. Houses for five astronomers and their families, as well as dwellings for service personnel, are under construction. There will be accommodations for visiting astronomers, as all of our instruments, especially the Grubb refractor, are available to foreign scientists who wish to work in the Southern Hemisphere.

In August and September, 1956, Dr. S. Arend came from Uccle, Belgium, to help recondition and adjust the 24-inch refractor. He also observed the opposition of Mars and gave an intensive course on theoretical and practical methods for observing minor planets. He is the codiscoverer of Comet Arend-Roland.

Our three Riefler standard clocks and four quartz crystal clocks will be kept in a temperature-controlled vault under the main building. For students and visitors, a number of instruments, including twin Zeiss 4-inch refractors, will be placed on the terrace.

There will be a new building for our standard Carte du Ciel astrographic refractor, which has a 13-inch objective of 11-foot focal length. Its plates cover a sky area two degrees square. The 11-inch visual Heyde refractor is to be located in a dome 26 feet in diameter. Like the 24-inch, it has a German-type equatorial mounting. Another major instrument, the Repsold $7\frac{1}{2}$-inch meridian circle, will be housed in a pavilion of new design. A $3\frac{1}{2}$-inch Bamberg broken-transit instrument will be mounted nearby.

LETTERS

Sir:

On page 277 of the April issue, I note that M. A. Ahad under the heading "An Observatory in Iraq" indicates his to be the only private one in the country. May I point out that in Iraq a dozen other amateurs, including myself, privately own and use observatories with a variety of instruments. A few of us are members of the British Astronomical Association and are very active in one or more sections of that organization.

Z. BISHREY
46T3/21 Karrada
Bagdad, Iraq

Sir:

The February, 1957, issue contained a very interesting article, "A Hollow Meteor Train," by Dr. Gerald S. Hawkins. The observations reported are quite important and the results good.

However, one incorrect statement is made: ". . . not more than a hundred or so long-enduring trains have been recorded since the beginning of meteor astronomy." From the author's previous sentence we infer he means a minimum duration of five minutes.

In my two papers on the subject (*Proceedings*, American Philosophical Society, Vol. 85, 1942, pages 93-135; and Vol. 91, 1947, pages 315-327), may be found data on over 700 trains having durations from five minutes to one or more hours, in the interval from 1833 to 1947. A third paper now in press will add more. Hence, Dr. Hawkins' estimate is perhaps seven times too low.

CHARLES P. OLIVIER
Flower and Cook Observatory

Sir:

During the May 5th transit of Mercury, I carried out experiments to determine the least optical power needed to show the planet in front of the sun's disk. In a 3-inch f/4.9 refractor at 27x, the planet remained visible with diaphragms as small as $4\frac{1}{2}$ millimeters.

To find the lowest magnification needed, I held an unmounted 2-inch f/5.5 telescope against a wall and could easily see Mercury at 6x. But it was not visible at 3x in a 1.2-inch f/5 finder.

With the 3-inch refractor, 76x, contact II was timed at 0:06:10 UT, using a watch corrected by WWV time signals. This was the moment when the black drop first formed; during the next 20 seconds it broke and reappeared several times.

ROGER J. CUFFEY
522 Eastside Drive
Bloomington, Ind.

SOME ADVANCES IN SOLAR RESEARCH

(Continued from page 467)

prominences can be so much cooler than the corona in which they are imbedded. Analysis indicates that a small condensation in the corona will rapidly lose energy by radiation in the far ultraviolet. As a result, the cool areas will grow in volume until some sort of balance is achieved.

The foregoing interpretation is based on observational data secured over the years, particularly at the High Altitude and Sacramento Peak observatories. For the data, I am indebted to their directors, Dr. Roberts and John W. Evans, and to many observers. Henry J. Smith, Harry Ramsey, and John G. Wolbach helped me especially by assembling and editing the film. The investigation was carried out under Air Force Contract 19(604)-146.

ASTRONOMICAL SCRAPBOOK

A South American Tragedy

AS THIS CENTURY opened, one of the bright lights in the firmament of young German astronomers was Friedrich Wilhelm Ristenpart. He was already well known in 1891, when at the age of 23 he obtained his doctor's degree at Strassburg, then the best graduate school of astronomy in Germany. His thesis was a study of fundamental astronomical constants and the sun's motion through space, as indicated by the proper motions of stars. For the rest of his life, star positions and motions remained his favorite astronomical subject.

This able young man was also an enthusiastic observer. At the observatory in Karlsruhe, where he became Valentiner's assistant in 1891, he would often during the same night make zone observations with the meridian circle, use the zenith telescope for latitude determinations, and finally measure comet positions with the refractor.

In 1898, when he moved to Kiel Observatory, Ristenpart began a huge undertaking: the collection of all the hundreds of thousands of star positions from all the catalogues of precision of the 18th and 19th centuries, and the publication of these positions, reduced to the same epoch, in a single master catalogue. Starting in 1900, the Prussian Academy of Sciences supported the enterprise financially. Today this great project is nearing completion; the many volumes already published of the *Geschichte des Fixsternhimmel* fill a large shelf in observatory libraries, and have been of very great value to astronomers concerned with stellar positions and motions.

Ristenpart had moved to Berlin in 1900 to supervise the bureau of the Prussian Academy where this work was being carried out. But even this labor did not sate his seemingly boundless capacity for work. In 1904, he also became lecturer in astronomy at Berlin University, making a name as a very effective teacher and public speaker. He found time for occasional observations of comets with the 12-inch refractor of the Urania Observatory in Berlin.

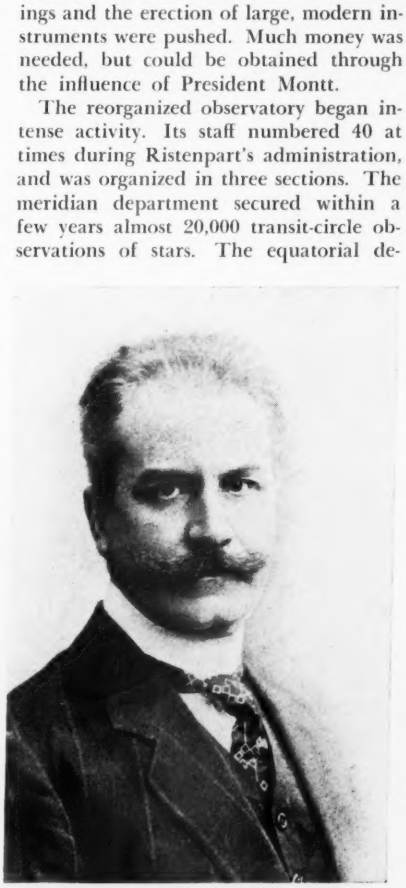
From this you can see something of the intense energy of the man, but also indications of a restlessness, and a desire to observe rather than spend all his efforts among the books and papers of his office. He was ambitious, and wanted a wider sphere of activity. With these facts, we can picture the mood in which he studied an invitation that reached him early in 1908 from the government of Chile, offering him the opportunity to establish a major astronomical observatory.

Dr. Federico Rutllant's article in this same issue of *Sky and Telescope* tells of the history of the Chilean observatory at Santiago, and its present flourishing state and bright future. But back in the first years of this century, the institution had fallen into inactivity and disrepair. Its director then was Jean Albert Obrecht, an Alsatian who had studied astronomy at Paris, but whose astronomical work in South America was minor. Obrecht seems, however, to have been a prominent and well-liked public figure.

In 1906, Pedro Montt became president of Chile. Being interested in astronomy, he took steps toward a thorough reorganization of the national observatory. This resulted in the invitation to Ristenpart to become director.

Sometime in July, 1908, the German astronomer definitely decided to accept a five-year contract with the Chilean government; he left Berlin on August 20th, and arrived at Santiago during the first days of October. Ristenpart immediately set to work with his characteristic enthusiasm and vigor to raise Santiago to the level of a first-class observatory. A new site was chosen, spacious and farther from the city lights, a greatly enlarged staff was enrolled, the construction of new buildings and the erection of large, modern instruments were pushed. Much money was needed, but could be obtained through the influence of President Montt.

The reorganized observatory began intense activity. Its staff numbered 40 at times during Ristenpart's administration, and was organized in three sections. The meridian department secured within a few years almost 20,000 transit-circle observations of stars. The equatorial department, whose chief was the able German astronomer Richard Prager, made many measures of the positions of comets and asteroids on a systematic plan, including a fine series of 139 positions of Halley's comet during its 1910 return. Another German, Walter Zurhellen, directed the astrophotographic department, and began work on the sky zone between declinations $-17°$ and $-23°$, which had been allotted by the Paris conference of 1887 as Santiago's share of the Astrographic Catalogue.



F. W. Ristenpart, who tried to build the world's largest observatory in South America, but whose efforts ended in personal disaster.

Ristenpart undertook many other projects. There were observations to follow the variation in latitude, work on star charts of the southern sky down to magnitude 10, and eclipse expeditions to Argentina in 1908 and Brazil in 1912. The latter expedition failed; it rained during the eclipse, and the instruments were lost in a shipwreck of the returning party.

When Ristenpart left his native land, the Prussian government had given him a two-year leave, so that he could return to a secure position if affairs in Chile did not work out. A few months after his arrival in South America, Ristenpart felt that conditions were so propitious that he decided with characteristic optimism to stay in Chile for the rest of his life. This optimism doomed him.

His loyal friend, President Montt, died suddenly on August 16, 1910. From this time on, the Chilean government lost interest in the new observatory, which began to appear more of a financial burden than a cultural asset. There was growing resistance to Ristenpart's requests for construction funds until, finally, the ambitious plans (which had called for the erection of no fewer than 29 buildings on the 27-acre site) had to be postponed to the indefinite future.

There were other troubles. Ristenpart was a hard man to get along with; forceful and self-assured, he made immediate decisions and held to them vigorously. His extraordinary capacity for work led him to make great demands on his staff—too great, they thought. Many of his people were government appointees who had little or no real interest in astronomy, and could not understand the director's motivation. Ristenpart, on the other hand, did not understand people.

Thus there arose an ever-deepening rift between the director and his staff, until the differences could no longer be kept inside observatory walls. He was forced to accept the government's plan that he turn over the administration to a Chilean while he retained direction of the scientific work. No solution to these problems came and, finally, Ristenpart's contract expired on February 15, 1913.

The failure of his glowing plans depressed him deeply, and the strains of the last few months had undermined his health and destroyed his ability to work. After deciding to return to Germany, he was momentarily buoyed with hopes for

the future. But on the early morning of April 9th he took his own life.

The German and Chilean accounts of Ristenpart's final crisis differ. The former suggests intrigues by subordinates, the latter, government action against an unbalanced autocrat. It is difficult to know, half a century later and a continent away, the part that politics and antiforeign feeling may have played. But undoubtedly the seed of the disaster was in Ristenpart's own personality.

Upon Ristenpart's death, the leadership of the observatory was temporarily given to the same man who had been appointed to investigate the charges against him. Then, on June 1, 1913, the popular but ineffective Obrecht again assumed the directorship, and the great dream was over.

JOSEPH ASHBROOK

Dr. Rutllant, present director at Santiago, has helped me with useful information, but he should not be held responsible for my interpretation. I have drawn freely from the accounts by R. Prager (*Vierteljahrsschrift* of the Astronomische Gesellschaft, *49*, 14, 1914), and by R. Grandón (*Anuario* for 1952 of the National Astronomical Observatory of the University of Chile).

QUESTIONS... FROM THE S+T MAILBAG

Q. Is there a difference in meaning between *seeing* and *transparency?*

A. Yes. Seeing refers to the steadiness of the image, and determines the fineness of the detail detectable with any one telescope at a particular time. The transparency of the sky is simply how well light can pass through it; the more transparent the sky the fainter the objects that can be seen.

Many telescope users record the quality of the seeing during an observation on a scale of 0 to 10, where 0 means worst, 5 average, and 10 exceptionally fine image steadiness. Similarly, transparency may also be described on a scale of 0 (worst) and 10 (best).

Q. Does the tenth satellite of Saturn called Themis exist?

A. Saturn has nine definitely known moons. Concerning a 10th satellite, the following information is given on page 393 of *Astronomy,* by Russell, Dugan and Stewart (Ginn and Co., 1926): "[W. H.] Pickering, in 1905, reported the discovery of another very faint satellite with a period of 20.85 days, which he named Themis, but the discovery has not been confirmed. It may be that one or more faint satellites of about that period exist."

Q. Why is Mercury's diameter given as 3,010 miles on page 422 of the July issue, instead of 3,100 miles?

A. In *Astrophysical Quantities,* by C. W. Allen (1955), Mercury's diameter is given as 4,840 kilometers, which converts to about 3,010 miles. W. E. S.

Hunting for Meteorites

Tips on the identification of meteorites are given by Oscar E. Monnig, of Ft. Worth, Texas, in the May issue of the *Junior Astronomer,* published by the Astronomical League.

Mr. Monnig first points out that when a fireball seems to reach the earth or to end low in trees, the meteorite has landed some 150 to 300 miles away. For meteorites to fall near the observer, the fireball should appear to fade out high in the sky.

Sounds from falling meteorites are also an indication of distance. Thunder from a meteorite's passage is often heard up to 50 miles from the point of fall, while within a mile of the falling body a whirring noise like that of an airplane flying with its motor cut may be heard.

Mr. Monnig states that the traces of gold and diamonds present in meteorites have no commercial value. It is the scientific importance that makes them worth hunting for. He gives the following suggestions on identification, which may be studied in conjunction with the article on meteorite classification by Frederick C. Leonard in the June issue of *Sky and Telescope,* page 370.

"The best single test for a suspected meteorite is to grind a small area on a clean carborundum wheel. A square inch or less is enough. As iron meteorites and some stony ones are very hard, it is best to select a small surface already nearly flat. If the grinding reveals a stony interior, look closely at the surface uncovered. See if any metal specks have appeared. They will look silvery.

"If metallic iron occurs in a stony mass, the piece is almost certainly a meteorite.

"An all-metal (iron) meteorite, when ground, will show the fresh iron interior at once; in such case, try a magnet as a confirming test, as any iron meteorite will be attracted by a magnet.

"Meteorites vary in size from pieces just large enough to recognize to huge masses of 50 tons or more. You would be most likely to find one weighing from an ounce or so up to 50 pounds. The size may be from less than an inch to several feet.

"Meteorites are usually heavier than ordinary rocks but this isn't always true. Iron meteorites are very heavy. They weigh almost three times as much as ordinary rocks of the same size. Stony meteorites are not much heavier than ordinary rocks. As to shape, they are usually very irregular and often roughly cone-shaped. They are never round.

"Freshly fallen meteorites are covered with a melted crust which is more often dull than shiny. It is always thin and usually black. Fresh crusts are often 'threaded' or in small ridges. These show the flow lines of the material which melted. The effects of weather change the crust quickly, making it dull or grey or even brown. The crust will tend to be destroyed in time.

"Old weathered meteorites generally are a rusty brown. Fairly smooth pits are sometimes present on the surface. The outside appearance is not a very good guide to meteorites except for experienced people.

"Don't break or cut apart a possible meteorite. You would reduce its scientific value. And, don't try to break it open or to cut off a piece with a chisel. It's too hard, anyway.

"Whenever an iron meteorite is ground to expose the inside, it will be seen to be fresh, metallic iron looking like silver. Stony meteorites, broken open, vary very much in appearance from dense, grainy orelike rock to very broken mixtures of materials. The general interior color may be anything from white to black, or even grey or green. It is most often a light to dark grey.

"On exposed interiors, the free iron will soon rust. Stony meteorites range from very hard to soft. *Meteorites are always solid or compact.* A meteorite never shows 'gas bubble' holes like slag. They are never frothy like some lavas or volcanic rocks.

"Meteorites are not flaming hot when they strike the ground. They don't make 'glowing craters' or 'burn for days.' They have been out in space and are very cold. Their flight of a few seconds through the air strips off most of the heated material. The rest, which hits the ground, will be solid and even cold."

Mr. Monnig points out that among terrestrial material hematite, a heavy iron oxide, is often mistaken for meteorite material; grinding the surface will show a metallic shine but not free metal, and such pieces are usually not magnetic. Slag or cinders are generally porous, and rocks that show crystals are usually not meteorites.

He gives the following check questions. If all the answers for an object are yes, it is almost certainly a meteorite. In a few cases some of the answers for a meteorite may be negative, but if most of them are no, it is probably not one.

Is the object solid? Irregular? Heavy for its size? Black or brown on the outside? Does it show metallic iron on a ground surface? Is it different from the neighboring rocks?

METEORITICAL SOCIETY

The 20th meeting of the Meteoritical Society will be held on September 3-4 at the University of California, Los Angeles. All scientific sessions, open to the public, will be in the Mathematical Sciences building. Dr. Frederick C. Leonard, of the university's astronomy department, is chairman of the program committee.

The central portion of a Fogelquist atlas chart, on the same scale as in the atlas itself. The trail of a bright meteor runs diagonally across the field, from a point near the Pleiades cluster and its nebulosity in the upper right to the Hyades in lower left center. Another cluster, NGC 1647, is above and left of the Hyades. Photograph by Rune Fogelquist.

A Swedish Amateur's Photographic Sky Atlas

FOR a long time I have wanted a star atlas that would be more detailed than the Skalnate Pleso or Norton's. But large professional works are expensive, and therefore I decided to make a photographic atlas of my own.

My program is being carried on with an f/4.5 camera of 1-inch aperture, about as small as can be efficiently used for astrophotography. But the camera has the advantage of covering a field 30 degrees square on a single 9-by-12-centimeter plate. It is used on my electrically driven homemade mounting, together with a 6-inch reflector and a 4-inch refractor.

The principal observing problem was to reach fairly faint stars without long exposure times. If an hour or more were required for every exposure, it would be difficult to preserve the homogeneity of the atlas, which would also then require several years to complete, as good observing conditions are rare in Scandinavia. And our winter nights are rather cold for an observer to attempt long, guided exposures!

A fast plate-developer combination provided the answer to this problem. Eastman Kodak scientific plates are expensive in Sweden, and the cheaper Ilford Astra plates are too slow. Finally I decided on Ilford HP3, developed in Microdol plus a sensitizing agent. In this way, a limiting magnitude of 11 is reached in an exposure time of only 20 minutes.

The color sensitivity of these plates is such that the relative visual brightnesses of the stars are roughly preserved, with blue stars coming out slightly too bright. The plate-developer combination gives high contrast and well-defined images.

The adjacent fields overlap by at least five degrees. To cover the available sky, one field is centered on the north celestial pole; there are eight plates with centers at declination $+70°$, 12 at $+45°$, 15 at $+20°$, and 15 at $-5°$. In all, there are 51 plates, covering the sky from the pole to 20 degrees south of the equator.

As a rule, plates are taken on the meridian, especially for southern fields. However, the areas near right ascension 18^h cannot be photographed while crossing the meridian in a dark sky at my latitude of 60° north. For the southernmost zone the exposures are 30 minutes long instead of 20, to offset partly the increased atmospheric absorption.

Making this atlas is not an easy task. To keep the standard high, only transparent, moonless nights without aurora are used. No less than 34 per cent of the plates taken so far have had to be repeated, because of emulsion faults, mishaps in guiding or development, and the intervention of clouds or northern lights.

By this spring the Milky Way areas of the atlas, consisting of 20 plates, were completed, and most of the rest of the sky had been covered. Here in Sweden midsummer twilight lasts all night, making the sky too bright for astrophotography, but I expect to obtain the remaining plates next winter. Among these are two that could not be taken during the last observing period because Mars and Jupiter were in their fields.

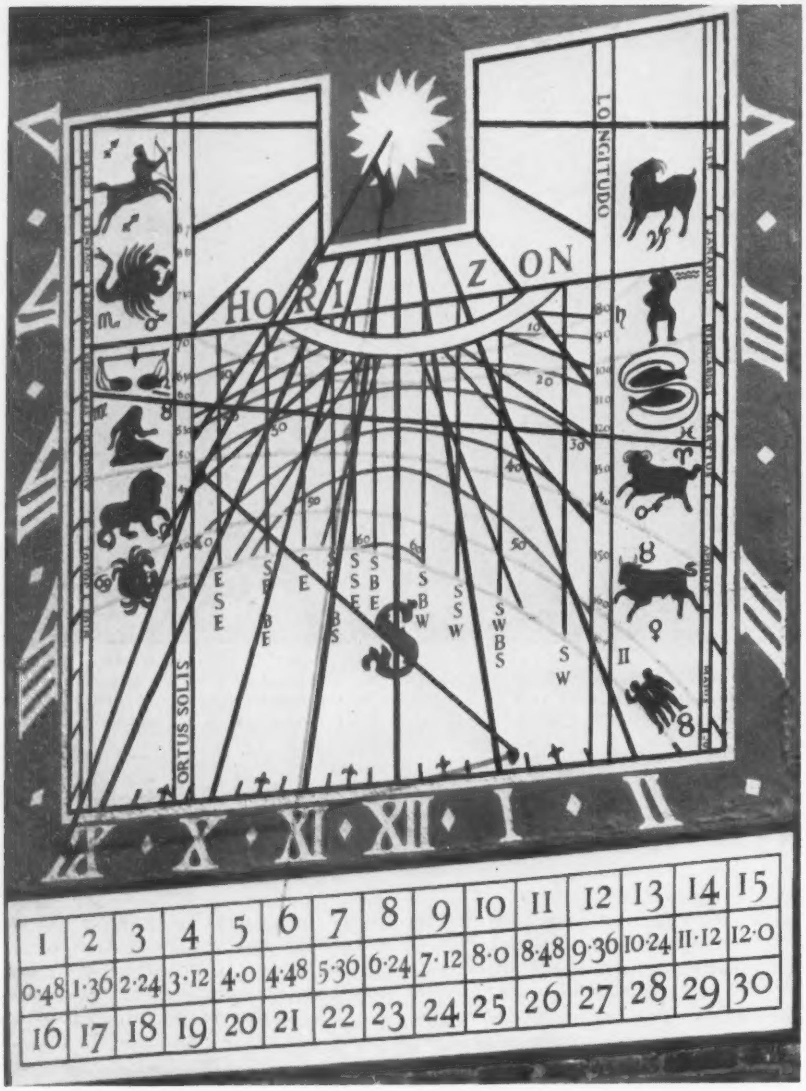
To make the atlas prints themselves, I am enlarging the original plates to about 9½ by 9½ inches, on grade 4 glossy paper. There will be no names or coordinates marked on the prints, as they are intended for use with one of the published atlases. The scale is slightly larger than that of the Skalnate Pleso atlas. For each print the observing date, sky conditions, co-ordinates of the center of the field, notations on asteroids that might be mistaken for stars, and other information will be given.

My "Amateur's Photographic Sky Atlas" is the work of an amateur and is meant for amateur use. I will be glad to answer questions regarding its availability if each one who writes to me will enclose a self-addressed envelope and an international reply coupon, which may be procured at any post office.

RUNE FOGELQUIST
Bösslinge, Börje
Uppsala, Sweden

About Sundials and Moondials

Hermann Egger
Zurich, Switzerland



The sundial at Queens' College is said to have been designed by Newton. It may be used as a moondial by means of the table of numbers below it.

THE PURPOSE of conventional sundials, both old and modern, found on the walls of many schoolhouses and public buildings, is to awaken in those who pass by an interest in a traditional part of astronomy. And this interest is heightened when a sundial can also be used as a moondial.

At Cambridge, England, on the north wall in Old Court at Queens' College, is a large sundial originally painted in 1733, but probably calculated by Sir Isaac Newton in 1725, two years before his death. As shown in the closeup picture, below the dial are three rows of figures giving dates and hour-angle corrections used to read time by moonlight, if one knows the age of the moon (time since new moon) in days.

To apply the moon corrections we should know how Newton's sundial works. On a support just below the sun symbol at the top of the dial, the style or indicator extends outward from the wall and downward (obliquely left in the picture). Its direction is parallel to the earth's axis, since the style of any hour-angle sundial points to the celestial poles. At its lower end the style joins two struts that support it; the foot of one of these struts is at the hour mark IX, the other just above I.

About midway along the style is a small black sphere, which is casting a shadow on one of the steep hyperbolas that indicate the sun's altitude in degrees. These hyperbolas are labeled 10, 20, 30, 40, 50, and 60, and the shadow of the small sphere falls on the 40° hyperbola. The shadow of the style is close to the XI-hour mark, so this was the apparent solar time when the photograph on this page was taken.

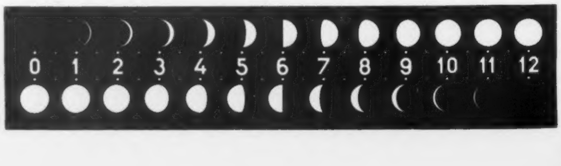
Across the central part of the dial may be seen labels for the points of the compass, below the vertical lines that indicate the azimuth of the sun. Much lighter flat hyperbolas are date lines that extend across the dial from the month labels and their respective zodiacal signs. The 12 "temporary" hours into which the ancients divided the day from sunrise to sunset are marked off by the shorter radiating lines (which actually should be wavy curves). The first and last of these markers coincide with the "Horizon" line, from the midpoint of which the other 10 appear to diverge.

The middle of the three rows of numbers for use with the moon shows the difference in hour angle between the moon and the sun, on the basis of a 30-day month. Thus, at 15 days the moon is full, opposite to the sun in the sky, and the scale shows that 12 hours should be added to the time on the dial read by the light of the full moon. Likewise, for all other ages of the moon, the hour angle with reference to the sun has to be added to the time read by moonlight on the dial; in this connection, the sun is considered to be always in advance of the moon in the sky, so far as daily rotation is concerned.

But the result will be only an approximation to the correct time; even when the equation-of-time correction is applied, the Queens' College sun- and moondial can tell mean local solar time by moonlight only roughly, because of the nonuniformity of the moon's motion. The use of approximate numbers for the moon's age will also hamper time-telling by this method.

The black-and-white drawing is a sub-

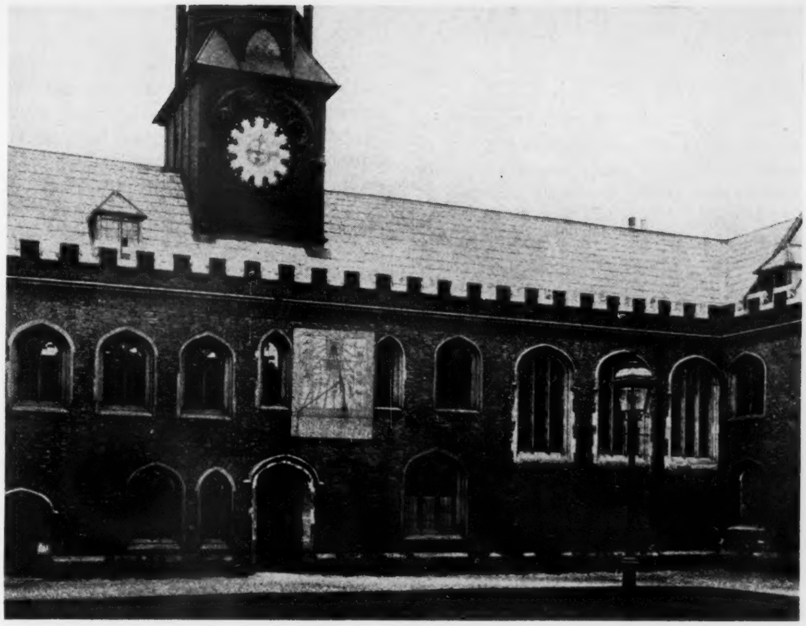
With the aid of this scale, many kinds of sundials may also be used as moondials.



stitute devised by the writer for the three rows of moondial numbers. It eliminates the need of knowing the age of the moon, for its appearance in the sky can be matched with some accuracy against its phases in the drawing. The numerals 0 to 12 indicate the corresponding differences between the hour angles of the moon and the sun, and some interpolation is possible. As in the system on the Queens' College sundial, the appropriate numeral must be added to the hour read on the dial by the light of the moon. This scale can easily be incorporated into a sundial, and is simpler to use and more accurate.

Furthermore, the differences in the night-to-night motion of the moon can be ignored, for the shape of the illuminated portion of the moon's disk depends only on its angular distance from the sun in the sky, or approximately the hour-angle difference between these two bodies.

Both moondial methods, of course, can be used only with sundials that measure time by the hour angle of the sun. They cannot be applied to azimuth sundials nor to those that indicate the hour of day by means of the height of the sun.



The location of the sundial pictured opposite is shown in this view of the north wall of Old Court, Queens' College, Cambridge.

WORD FROM DOWN UNDER

(Continued from page 463)

Nevertheless, we in the Southern Hemisphere are inclined to envy northerners their possession of the historically famous circumpolar constellations—the Big and Little Dippers, Cassiopeia, and others, these being either invisible or poorly seen from mid-southern latitudes. We have instead the Large and Small Magellanic Clouds, and the Southern Cross, but few of our circumpolar groups possess historical glamor. And we have no star to compare with Polaris. Around the south pole the sky is unattractive. Sigma Octantis, barely visible to the naked eye, is a pole star that fails to arouse our enthusiasm.

The inversion of the constellations is of little consequence once the observer is used to it. Orion's sword hangs upward from the belt, but M42 is just as impressive a nebula as it is to northerners. One of the finest constellations is Scorpius, which passes near our zenith. It abounds in open clusters and other objects against the background of the Milky Way. The Scorpion illustrates low-altitude "magnification" to a marked degree, looking almost monstrous near the horizon but quite innocuous when overhead.

In the Southern Cross, which is circumpolar for most of us, Alpha Crucis is an attractive double star. Alpha Centauri is another; with Beta Centauri it points to the Southern Cross. The dazzling Milky Way between Crux and Monoceros is quite indescribable, a stretch of sky unsurpassed in the south. Of the other circumpolar groups, Carina is one of the best constellations for both naked-eye and telescopic observations. Its brightest star, Canopus, is second only to Sirius in the entire sky. The globular cluster, 47 Tucanae, is a favorite with many observers. Among the ATM's the most popular double star is probably Beta Tucanae, fainter but easier to separate than the famous Gamma Virginis near the celestial equator.

Both Magellanic Clouds are easily visible to the naked eye, the larger one, studded with clusters, being a good telescopic study.

Southern stargazers are, on the average, some 10 degrees closer to the equator than northerners, and our observing conditions are generally milder. In the writer's locality many people have never seen snow. Domestic room heaters are in use from about May to September, but hardy souls can dispense with them altogether.

In the Australian states interest in amateur astronomy is growing steadily, with telescope making activities increasing. In New Zealand, the hobby of astronomy is thriving—amateurs have always been keen down there.

CHARLES WESTCOTT
17 Waite St.
Blackwood, South Australia

In an early Harvard photograph of the southern Milky Way, Alpha Centauri is at the extreme left edge, with Beta Centauri above and to its right. These two stars point to the top of the Southern Cross, a kite-shaped figure standing upright alongside the Coalsack dark nebula. Gamma Crucis, at the top of the cross, seems faint because of its redness; the emulsion was blue sensitive.

NEWS NOTES

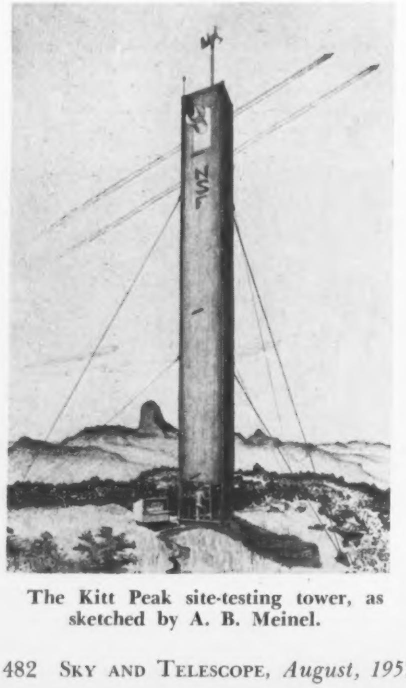
SITE SURVEY PROGRESSES

Sixty-foot testing towers that carry instruments to make automatic records of seeing and transparency conditions are now located at four places in Arizona that are being tested for the new National Astronomical Observatory (see *Sky and Telescope*, January, 1956, page 107).

The sites are at Kitt Peak, southwest of Tucson; Hualpai Mountains, southeast of Kingman; Summit Mountain, in the Williams area; Chevelon Butte, south of Winslow. Advanced plans are under way to add Junipero Serra Peak in California as a test site (May issue, page 320).

Each of the towers is triangular in shape, triple-shelled, with a ladder inside for access to the top. A telescope is permanently pointed at Polaris, to monitor the seeing. About once a month a member of the staff, under the direction of Dr. A. B. Meinel, visits each tower and collects the records for study at the Phoenix headquarters of the project. The test program will take about 18 months, and other sites will be tested if none of these proves satisfactory as a location for a large observatory.

At Kitt Peak excellent results have been obtained by Claude Knuckles, principal technician for that site. This was the most difficult place to develop, because of the lack of roads and the fact that it is located on an Indian reservation. It was only after the Papago tribal council had visited Steward Observatory at Tucson and observed the moon through its 36-inch reflector that permission was given for white men to lease land on the sacred mountain. Construction of an access road by Pima County, erection of the tower, and associated activities required 11 months.



The Kitt Peak site-testing tower, as sketched by A. B. Meinel.

The first telescopes of the National Astronomical Observatory, two 16-inch aperture reflectors for final site testing, are nearing completion. Engineering is completed for the 36-inch telescope, which is now ready for shop work. The 80-inch telescope is still being designed, but engineering of a selected design will be undertaken within the next few months.

PRINCETON'S STELLARATOR

In the intensely hot interiors of the stars, one of the principal energy-producing processes is the fusion of light elements, such as the isotopes of hydrogen. The hydrogen bomb represents man's first large-scale success in duplicating such fusion, but once the energy of the bomb starts being released it proceeds to explosive proportions in a very short time.

The director of Princeton University Observatory, Lyman Spitzer, Jr., suggested to the Atomic Energy Commission in 1951 that work be started to find methods of slowing the rate of nuclear fusion so that industrial applications could be found. He pointed out that fusion occurs most readily with deuterium, the isotope of hydrogen of atomic weight 2. Although only one deuterium nucleus is present in water for every 6,400 nuclei of ordinary hydrogen, the total amount of deuterium in the earth's oceans is enormous and could provide a practically inexhaustible source of power.

Thus, under Dr. Spitzer's direction, Project Matterhorn was set up, and a device called a *stellarator* ("stella" and "accelerator") was developed. It consists of a hollow tube containing ionized gas which is confined in a magnetic field produced by external coils. The gas is to be heated to temperatures that may reach millions of degrees, yet it must be retained within the tube for sufficient time to allow fusion reactions to take place.

In April of this year, plans were announced for the construction of a large stellarator, for experimental work not feasible with the smaller models already in use. Subject to the approval of Congress, work on facilities to house the device will begin next year, and experiments with it may start late in 1960 or in 1961.

NEAREST VISUAL BINARIES

Although some 40,000 double stars are known, there are so few astronomers who measure them that it is a serious problem to select the systems most deserving of observation. In the December issue of the *Astronomical Journal*, Olin J. Eggen, now at Greenwich Observatory, presents a list of 155 double and multiple systems within 65 light-years of the sun. He suggests that these nearby systems should receive more attention from astrometric, spectroscopic, and photometric observers.

The list is supplemented by detailed notes, including observations of magnitudes, colors, radial velocities, and parallaxes, as well as position angles and separations. Many of the binaries are familiar systems, like Alpha Centauri and 61 Cygni. There are also such curiosities as 104 Tauri, whose period of orbital motion Dr. Eggen suggests may be as short as 1.2 years; and there are five systems in which one component is a flare star. In the note on Sirius, he revives the proposal that its white-dwarf companion may itself be a close double.

SEARCH FOR FAINT VARIABLE STARS

In June, 1953, a conference on the coordination of galactic research was held in the Netherlands, under the auspices of the International Astronomical Union. It was proposed that a large-scale systematic search for faint variable stars be made, in order to improve our knowledge of the central parts of the galaxy, from the distribution of such objects as RR Lyrae stars, semiregular and long-period variables.

For this project the 48-inch Schmidt telescope on Palomar Mountain, with its great light-gathering power and wide field, is an ideal instrument. The completion of the sky survey, on which the telescope had been engaged for years, made it possible for a program of this sort to be undertaken. In April, 1956, Lukas Plaut, of the Kapteyn Astronomical Laboratory at Groningen, Netherlands, went to Mount Wilson and Palomar Observatories as a guest investigator.

Between May and November of that year, 100 photographic and 20 photovisual plates were taken for each of four regions by Dr. Plaut, with the assistance of Charles E. Kearns. These nearly 500 plates comprised the second largest pro-

IN THE CURRENT JOURNALS

A ROCKET AROUND THE MOON, by Krafft A. Ehricke and George Gamow, *Scientific American*, June, 1957. "Once man has successfully launched [the] artificial satellite, the next interesting target in space, of course, will be the moon. How soon will we reach the moon? With luck and sufficient effort, we ought to be able to do it within five years. . . . The trip to be considered in this article will be by an 'instrumental vehicle' which will fly around the moon without landing. . . ."

TRANSOCEANIC TV DX, by Calvin R. Graf, *Radio-Electronics*, July, 1957. "With the 11-year sunspot cycle expected to hit its peak in late 1957, the possibility for transoceanic television reception becomes more likely as the sunspot number increases."

gram that had been carried out with the 48-inch Schmidt.

Three of the four fields selected for the research were at the same longitude as the galactic center, but at latitudes of +28°, +12°, and −12°. Thus they lay in a strip perpendicular to the galactic plane and including the center of the galaxy. The fourth field, for comparison purposes, was in Cygnus, approximately at right angles to the direction of the galactic center. The chosen fields have nearly uniform interstellar absorption.

The plates are now being studied in Groningen. The program is being supported by the Netherlands Foundation for Pure Research, by Commission 38 of the IAU, and by a Fulbright travel grant.

AUGUST AAS MEETING

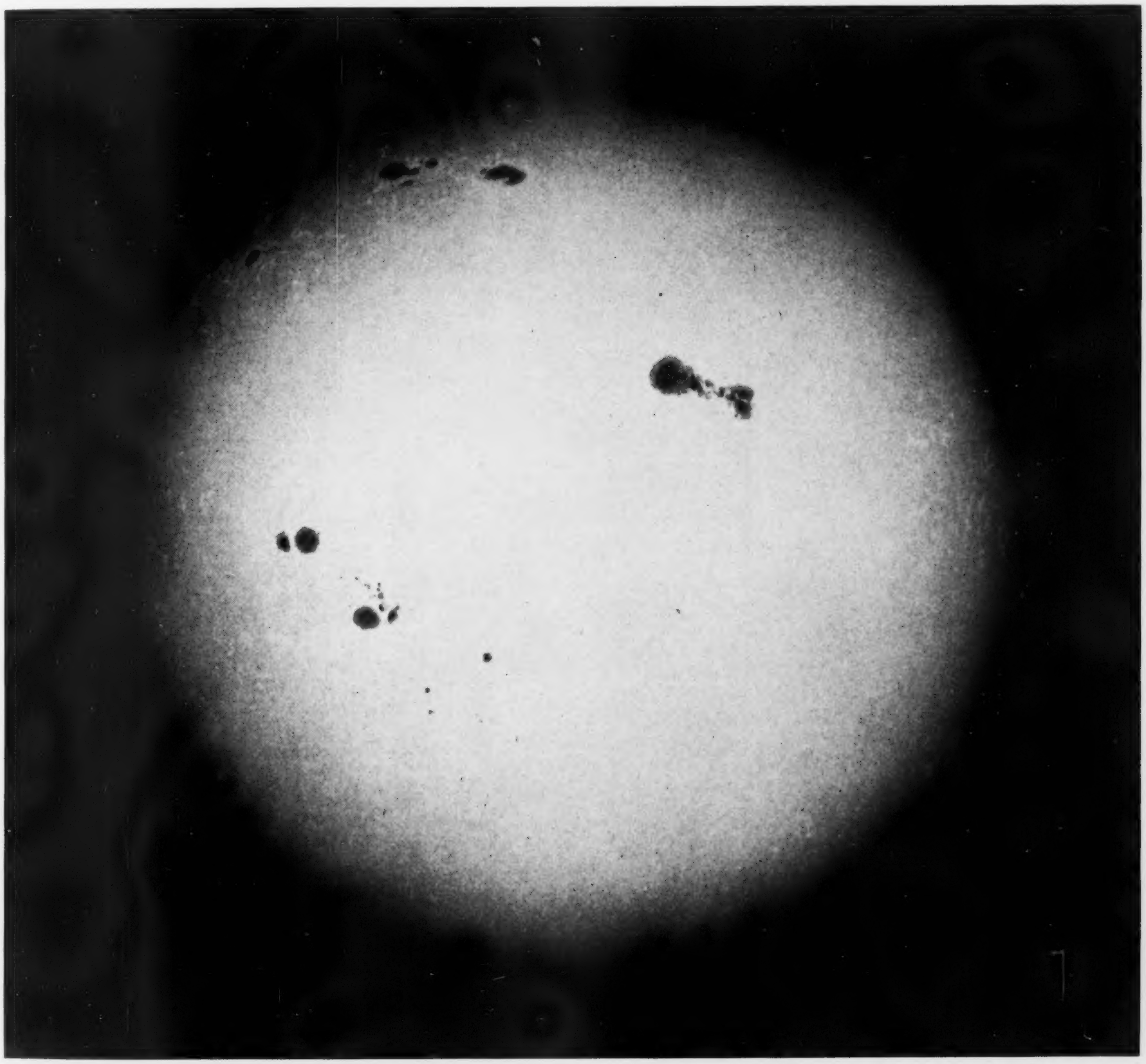
The American Astronomical Society will meet on August 18-21 at the University of Illinois Observatory, Urbana, Illinois. The five sessions for papers will be held in the Gregory Hall auditorium. A feature of the program is a symposium on radio sources outside our galaxy. The Russell lecturer is Dr. Otto Struve, director of Leuschner Observatory, who will discuss the double star Beta Lyrae.

ARTIFICIAL SATELLITE NOTES

Although most of the American artificial satellites in the current IGY program will be 20-inch spheres, one of only 13-inch diameter is to be used in measuring the earth's magnetic field. The magnetometer itself will be in a box about 3½ inches on a side, supported by foot-long legs from the spherical shell.

In this particular experiment, the data will be telemetered to the ground with a power of 80 milliwatts, in a message lasting eight seconds and begun on command.

On the morning of May 1, 1957, a Viking rocket was fired in such a way that at a height of 120 miles it turned horizontal, and a missile representing the third stage was successfully launched from it. This operation was tracked satisfactorily, but no second stage was used, and the third stage was not the final version.



Late in June the solar surface showed extraordinary sunspot activity. This photograph was taken June 24th at 7:13 a.m. Eastern standard time, by Mrs. Winifred S. Cameron at the U. S. Naval Observatory, under good observing conditions. South is at the top. The great single spot in the group above and to the right of center is probably the largest individual spot observed in this cycle. It has an area of 25 square degrees, and the whole group covers about 47 square degrees. Near the top is a major group at about 35 to 40 degrees south latitude, one of the largest seen in 40 years so far south on the sun. On the same day, a solar flare was observed in Europe. Official U. S. Navy photograph.

Amateur Astronomers

SOUTHEAST CONVENTION

Over 50 members and guests representing nine regional clubs in four southeastern states attended the Southeast Region convention of the Astronomical League at the University of North Carolina, May 4-5.

Dr. Carl Seyfert, director of Dyer Observatory, Vanderbilt University, evaluated astronomical research as a present-day applied science. This theme was extended to contributions by amateurs in talks by Miss Grace Scholz, president of the league, and Dr. Armand Spitz, Smithsonian Astrophysical Observatory.

A panel composed of Llewellyn Evans, Chattanooga, Tenn., Leonard Abbey and H. R. Hudson, Atlanta, Ga., discussed observing problems and methods. Talks given by regional members included "A Universal Star Chart," Joseph Schoebert, Eau Gallie, Fla.; "Evidence of a Supergalaxy," C. H. Holton, Atlanta, Ga.; and "Automatic Celestial Navigation," Mr. Hudson.

The Charlotte Amateur Astronomers Club exhibited a complete MOONWATCH station in the basement of the Morehead Planetarium. Following a planetarium demonstration, a 16-mm. sound motion picture, The Moon, was presented by the Jacksonville Amateur Astronomers Club (see January issue, page 117).

Elected as regional officers for the coming year were: Mr. Schoebert, chairman; William Close, Atlanta, Ga., vice-chairman; Harry Johnson, Atlanta, Ga., treasurer; and the undersigned, secretary.

JOHN A. EBEL
2973 Downing St.
Jacksonville, Fla.

AAVSO AT MONTREAL

The 46th spring meeting of the American Association of Variable Star Observers was held May 31-June 2 in Montreal, Canada, upon the joint invitation of Sir George Williams College and the Royal Astronomical Society of Canada, Montreal Centre.

In the opening talk, Dr. J. S. Marshall, McGill University, pointed out that terrestrial storms can be observed by radar provided the clouds contain large droplets of water, or snow crystals. An exciting climax was the showing of motion pictures of the approach of a storm first sighted over 100 miles away. This dramatic sequence was made by photographing the radar screen, showing a five-hour storm in about five minutes. The storm studies are being carried out at the Dorval Airport, where the meteorological laboratory staff explained and demonstrated the methods of research to AAVSO visitors.

Papers by the members included a variety of subjects, from variable stars to unidentified objects. Dr. P. M. Millman, National Research Council of Canada, described his work in connection with the IGY meteor program *(Sky and Telescope,* May, 1957, page 317). He has established a station in the Canadian Arctic at about 82° north latitude, which is the northernmost inhabited locality.

Lewis Boss, chairman of the photoelectric photometry division, reported that the AAVSO is ready to expand its activities in the field of electronics. The division has been developing methods of constructing photoelectric photometers for use by members and other observers. The AAVSO *PEP Handbook* is now ready for distribution.

Following the convention dinner, the Montreal Centre was host at its new observatory building on the campus of McGill University. The members have renovated an old building, which now has a large meeting room, library, and dome temporarily housing a 6-inch refractor.

The Canadians arranged a unique farewell by providing a special flight over Montreal and along the St. Lawrence Seaway project. One of the new Trans-Canada Airlines turboprop Viking planes was used—an experience in itself, even for veteran airline passengers.

R. NEWTON MAYALL
16 Madison St.
Cambridge 38, Mass.

At the MOONWATCH station of the Mount Diablo Astronomical Society, Amy Glines (standing) and Norm McRae, high school science teacher, show an observing instrument to a visitor. There is a timing trigger switch at each post. In the distance at the left is Mt. Diablo, for which the society is named. Photograph by Donald F. Charles.

MOUNT DIABLO SOCIETY

On March 20th the newly organized Mount Diablo Astronomical Society held an open house of its MOONWATCH station, located at the home of its chief observer, William Greenwood, 448 Coralie Drive, Pleasant Hill, Calif. About 200 visitors saw a special "satellarium" show, the meridian fence of 10 satellite-tracking telescopes, sunspots projected on a ground-glass plate, and other astronomical exhibits.

The "satellarium" show was devised by two of the club's members. It demonstrates the motion of a satellite in an orbit inclined at 40 degrees to the equatorial plane of a rotating earth. The model is complete with fluorescent continents, and shows the shift of the line of nodes of the satellite's orbit. A tape recording explains the exhibit for local civic and educational groups. By these showings, we have been able to enlist new members, draw financial assistance, and educate the community on the satellite program.

Our society is comprised of several adults and junior college and high school students from the central portion of Contra Costa County. Several members own 6-inch reflectors and one has an 8-inch refractor.

DONALD F. CHARLES
868 Audrey Court
Pleasant Hill, Calif.

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- Double-draw Focusing Tube for any eyepiece
- Precision-fashioned 54" Bakelite Tube

Write Today For Complete Details

ON THE PROBLEM OF CHOOSING A TELESCOPE

The choosing of a personal telescope nowadays must be very difficult for any newcomer to the field of astronomy. Thirty years ago when we ourselves became amateurs there was not any "Sky and Telescope" magazine to bedazzle our eyes every month with its host of instrumental offerings for every purse and purpose. Back in those practically prehistoric times you could arrange to have a refractor custom-built at home or abroad, or you could make yourself a reflector if you had heard of the wonderful new book just published by the now legendary A. G. Ingalls, called "Amateur Telescope Making." Since there were almost no war-surplus items, a great many of us got our first glimpses of the sky through some battered spyglass from a dusty pawnshop.

Today your choice is wide indeed, but choosing is not easy. Should it be a reflector or refractor? Should you buy a lot of aperture and skimp on mounting, or vice versa? Should you make part of it yourself? Should it be portable, semiportable, or a permanent job with some sort of shelter? How big ought the doggone thing to be? What power should it have, and how many eyepieces? Above all, since everybody says his telescope is wonderful, whom can you believe, and what size and make are really the best?

We'd like to talk about size of aperture this month. As you know, the larger the aperture, the smaller the diffraction image, and the greater the resolving power. Theory says so, and controlled laboratory tests confirm it for all optical systems of requisite quality. Thus one may test a large lens or mirror in the laboratory and secure wonderful resolution, only to mount it and have it prove most disappointing on the sky itself if seeing conditions are not right. Until quite recently, little thought had been given to improving the inherent defects of the conventional 18th century refracting and reflecting telescopes.

It took 50 years for the simple reflector of Newton, and the compound ones of Cassegrain and Gregory, to come into use, and about a century to perfect the so-called achromatic lens. At the turn of the 20th century, the catadioptric or mixed-lens-and-mirror systems of Goerz and Schupmann wholly escaped the notice of astronomers, while as late as 1930 Bernhard Schmidt's invaluable telescope was invented but went begging for many years. Then in 1944 Maksutov's classic paper on the all-spherical catadioptric systems appeared in the "Journal" of the Optical Society of America, but created no noticeable astronomical furor.

In 1946, feeling that something important to astronomers everywhere should not be overlooked, the Questar project was embarked upon. Eight years and a quarter-million dollars later the first Questar telescope was sold from our announcement in the June, 1954, issue of "Sky and Telescope." At one stroke the wonderful new catadioptric optics were introduced in an 89-mm. photovisual form, and for the first time a compound telescope was in regular production, with the only f/2 Cassegrain design of which we know.

Without going into the myriad improvements and elegances of this delightfully compact new instrument, we were much impressed by the better-than-theoretical performance of our little artifact. As public acceptance grew, others also discovered that nature indeed seems to favor the superfine small aperture. The series of lunar photographs taken with their Questar by the Davises of Florida, who last December were absolute novices at this sort of thing, not only astounded us, but, we are told, quite astonished the astrophotographic experts at Eastman Kodak Research Laboratories.

As the returns gradually reach us from Questar owners everywhere, in far places and from several continents, it seems that their experience with the superfine Questar's 3½-inch aperture is often similar. The new Questar optics in their short, closed 8-inch tube seem able to pierce poor seeing like a keen rapier, giving a respectable image in seeing so poor as to cripple larger apertures severely, and in fine seeing reported as nearly equaling the performance of perfect 6-inch refractors and 8-inch reflectors. This sounds like such a whopping claim that we are glad only to be passing on what people tell us. To what extent the unrivaled observing comfort of Questar contributes is hard to say, but it is probably considerable.

A typical experience is that of Mr. M, who is president of a large corporation, and who purchased his first Questar in July, 1954. We thought you'd like to read two letters from him in our files, which we publish with his permission.

"I expect you will remember me as one of the earlier purchasers of Questar. . . . I was a novice at astronomy at that time although experienced with many types of optical instruments.

"About a year ago I got all fired up with enthusiasm and ambition and decided that my Questar was not sufficient for my needs—I had to have something bigger and better. Consequently, I purchased a 4-inch refractor (which didn't do a thing that Questar couldn't do better and besides was a major project to set up and use), disposed of this, and now own a very good 8-inch reflector.

"My Questar had been admired by Dr. X, professor of astronomy at the college here, so in a rash moment I presented it to the school. I do not regret this because it is now being used in the best possible manner, but I miss it. After having experience with the larger instruments I now fully appreciate the importance of Questar's ease of operation. I also know that although in theory these larger scopes should outperform Questar, in practice they don't always do it. In fact, I am wondering if the larger instruments are really worth it to the average amateur. In September I had a chance to view Mars through a large observatory telescope and at the same time compare it with a 5-inch refractor. To me there was not a nickel's worth of difference, and Dr. X himself spent most of his time at the 5-inch. Of course, I realize there is no substitute for aperture when it comes to viewing and photographing the far-distant and faint objects, but as I see it, there is not much useful or interesting work that an amateur can do in that field anyway."

(This letter ended with shipping instructions for another Questar, receipt of which Mr. M acknowledged Nov. 26, 1956, saying, "The weather here is poor now . . . I have learned never to judge performance on one night's viewing.")

Later, on June 15, 1957, we received the following letter from him:

"Just a note to tell you what excellent results I obtained in observing last night. Although the moon was full, it was one of the best nights for seeing in my experience.

"At 160 power, Cassini's division in the ring of Saturn was plainly visible, as was the apparent shadow of the rings on the surface of the planet itself. Two of Jupiter's bands were quite prominent, with an occasional suggestion of a third. When I switched to my 8-inch reflector, I found that very little more detail on either of the planets could be observed.

"At approximately midnight, when Lyra was approaching the zenith, I obtained the most perfect split of the Epsilon Lyrae pairs that I have ever observed with any instrument. Although this separation of about 2 seconds is well over Questar's theoretical limit of approximately 1.3 seconds, I was most gratified, since in my experience it is most difficult ever to utilize an instrument's theoretical limit."

This is another moon picture by a Questar owner, showing the south central portion of the moon's disk, in the region of Mare Nubium. The prominent crater near top center is Tycho, with its central mountain.

The list of Questar owners is now a most impressive one. Many government agencies beside the armed services are represented, as are industrial users such as Corning Glass and Sperry Gyroscope. Men and women in all walks of life are Questar owners, and many of them are quite distinguished persons. Some teachers of astronomy at schools, colleges, and universities are finding Questar so rewarding in a number of ways that their large instruments are only used when unusually fine seeing justifies the inconvenience.

If you, too, have become tired of coping with the burden of large single-purpose telescopes, perhaps you would like to learn more about the incomparable Questar. Literature and details of our time payment plan are yours upon request.

The DeLuxe Questar at $995 and the Field Model at $495 are identical but for their mountings.

Questar

QUESTAR CORPORATION
New Hope, Pennsylvania

A PANORAMA O

AMERICA'S leading illustrator of space-travel subjects, Chesley Bonestell, has executed this 40-foot mural as the centerpiece of the astronomical exhibits in the main lobby of the Hayden Planetarium, Museum of Science, Boston, Massachusetts. He depicts in color a hypothetical lunar landscape, as it might be seen by a visitor to th moon, standing on the inner slope of a crater wal and looking across the 30-mile crater floor.

Since there is no appreciable atmosphere on th moon, the sky appears jet black, filled with star Some distant tall mountains are glaringly brillian

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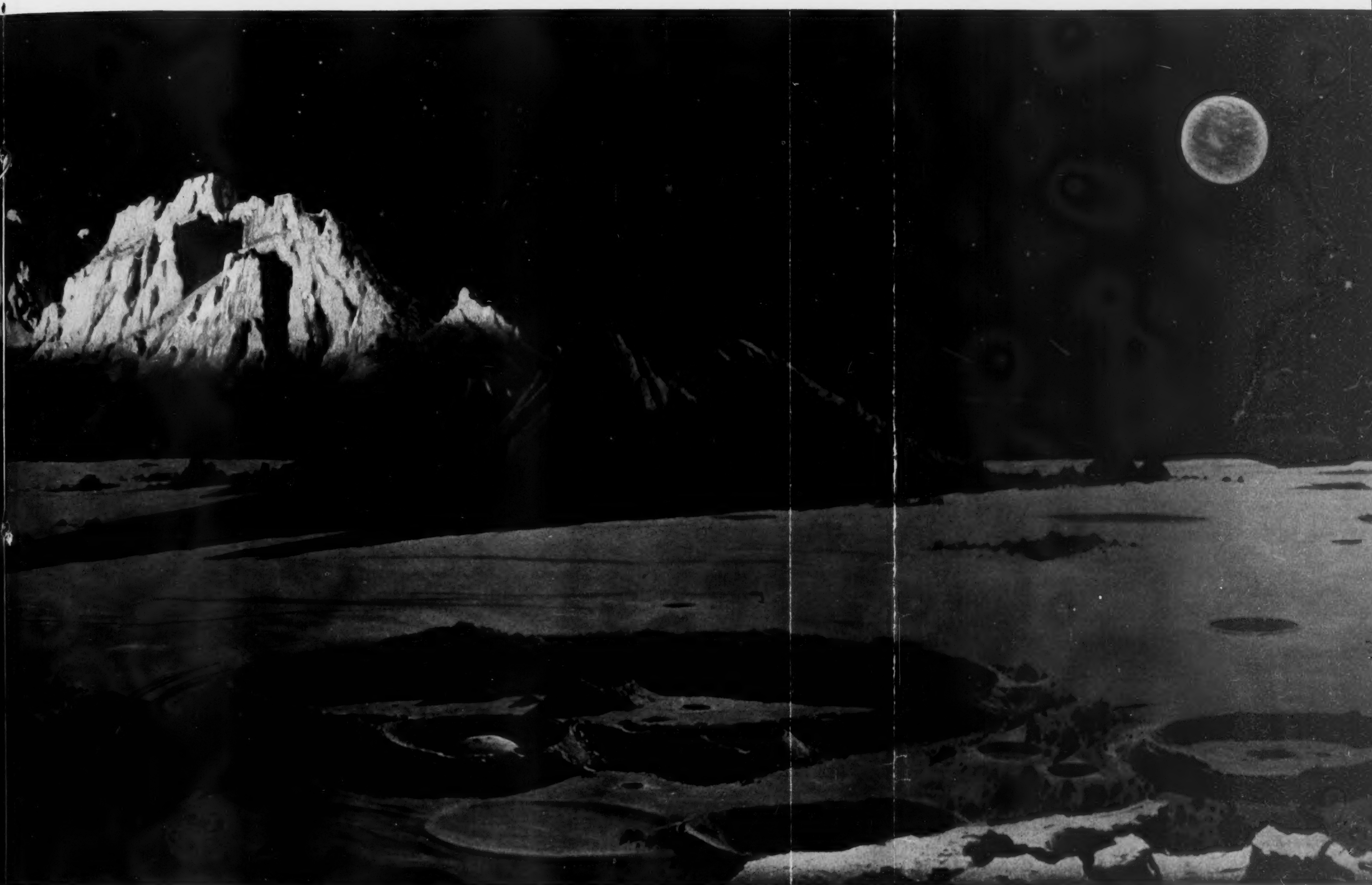

ON THE MOON — Depicted by CHESL

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in direct sunlight, while other peaks and the crater floor are bathed in bluish light from the earth, some 60 times stronger than the light we experience from the full moon. To the right of the mural's center, the earth itself is seen, apparently suspended among the stars of Ophiuchus.

Painted in three sections at the artist's California studio, the mural was hung in place by Edward K. Perry Co. Mr. Bonestell himself did the blending of the surface joints. This permanent feature of the Hayden Planetarium was dedicated in the spring of 1957.

THE ARTIST'S NOTES tell us that the 10-by-40-foot painting has a vertical visual angle of 20 degrees and a horizontal angle of 72 degrees, with the proper viewing point 28 feet in front of the picture. From that distance the earth in the lunar sky subtends its actual apparent diameter of two degrees.

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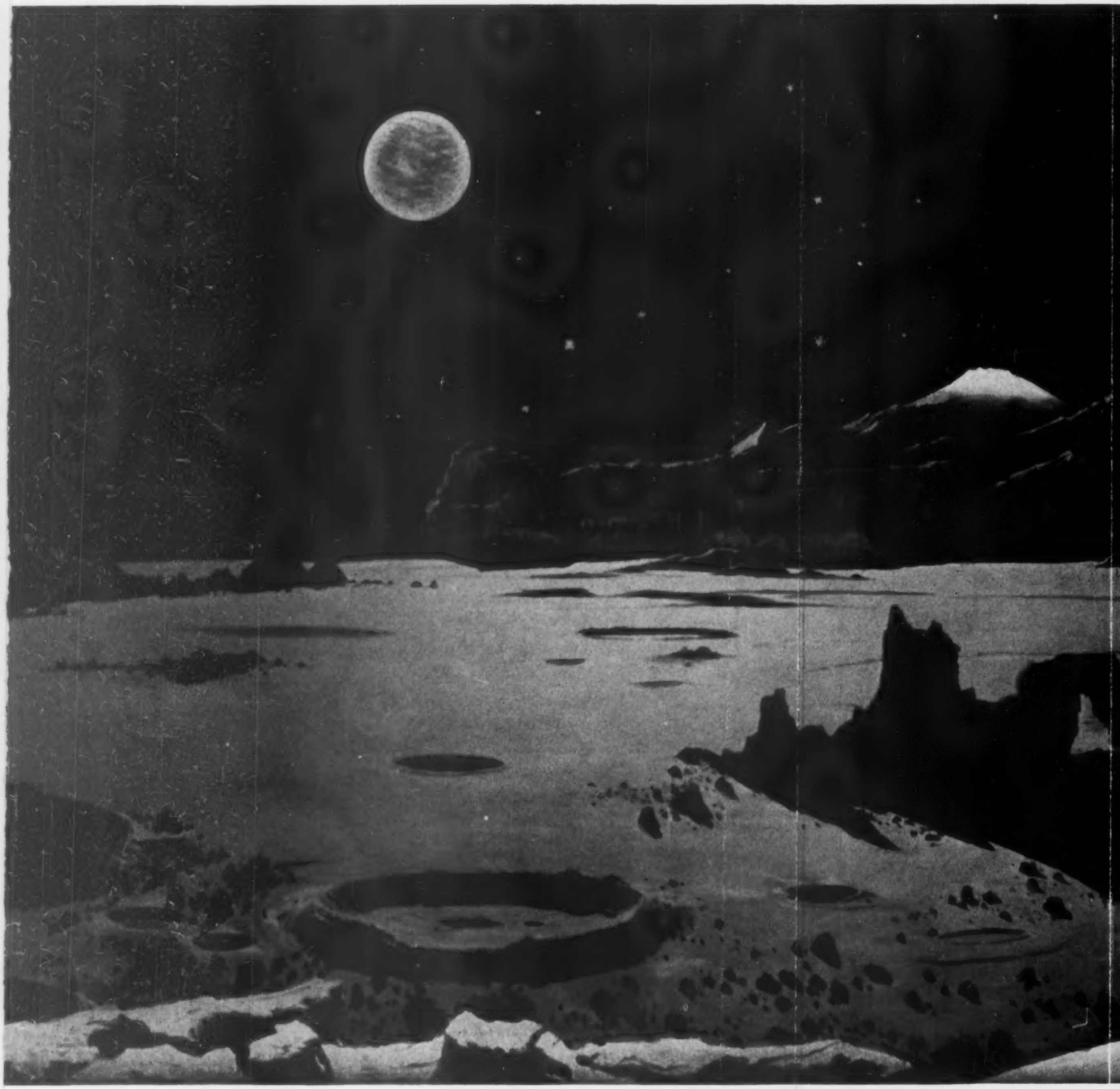

Depicted by CHESLEY BONESTELL For the

THE ARTIST'S NOTES tell us that the 10-by-40-foot painting has a vertical visual angle of 20 degrees and a horizontal angle of 72 degrees, with the proper viewing point 28 feet in front of the picture. From that distance the earth in the lunar sky subtends its actual apparent diameter of two degrees.

Jupiter is the bright planet over the central peaks, while Mars is near the 16,000-foot peak to the left. The ecliptic passes approximately through these and the earth. It is June-July on our planet, as its north pole is tipped about 23 degrees toward the sun. The reflection of the sun is on the Lower California peninsula of North America. Parts of the Milk as hazy patches of light.

The observer's position is ab above the floor of a crater locatec from the moon's north pole and the left of the center line of the l crater is similar to Albategnius,

or the Hayden Planetarium, Museum of Science, Boston

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lbategnius, although less
than half its size. The two central peaks are more than 5,000 feet above the crater floor, which has wavy ridges, cracks and rills, partly submerged craters, peaks and cinder cones, and craterlets perhaps formed by meteoritic impact. The crater floor is presumed to be covered with pumicelike dust.

Although no natural bridge has been definitely observed on the moon, Mr. Bonestell depicts to the right of center a "lava arch" and crag 1,000 feet high. At the far left are rocks crumbled by the extremes of heat and cold that prevail on our satellite.

Copyright, Boston Museum of Science

BOOKS AND THE SKY

ARIZONA'S METEORITE CRATER

H. H. Nininger. American Meteorite Museum, Sedona, Arizona, 1956. 232 pages. $3.75.

EACH YEAR increasing numbers of people visit the famed national parks in the western United States, and some of them also find their way to a landmark which appeals especially to those with an interest in "other worlds than ours." As long ago as 50,000 years, a cosmic missile struck the earth in north central Arizona and blasted a crater some 4,000 feet in diameter and 600 feet deep, which was pictured on the center pages of the June *Sky and Telescope.*

The Barringer meteorite crater has been known to the world for less than 100 years, and only some 30 years ago was the fact of its meteoritic origin first generally accepted. Since 1939, the author of this book, who is director of the American Meteorite Museum, has been gathering factual data about the crater, and the subsequent discoveries serve to indicate how much remains to be learned. He emphasizes the importance of Barringer crater studies in the identification of craters in other parts of the world that may have been similarly formed.

The early history of the crater reads like a mystery story. The meteoritic theory of its origin was difficult to uphold. An eminent scientist of the U. S. Geological Survey even reversed his earlier belief which had favored this theory. And then there was the failure to find a large mass buried beneath the crater itself. In 1929, however, F. R. Moulton indicated by his calculations that most of the original mass of material necessary to form the crater by impact would have been vaporized.

The second and larger part of the book is concerned with Dr. Nininger's efforts to increase evidence by field research. Objections from property owners prevented complete surveys on several occasions and must have been exasperating, although he expresses no complaint.

Much of the land surrounding the crater is now owned by the state of Arizona, but there is no special administrative attention given to it. We cannot but regret that this region is not a national monument. This may be partly a consequence of the tardy recognition of its importance. Even now, newly erected buildings on the crater rim may further hamper scientific work.

The author's findings, related in a way that brings out the thrill of discovery, have principally concerned small particles of meteoritic material previously overlooked. Evidence for an original mass of many thousands of tons is at hand (*Sky and Telescope,* June, 1957, pages 366-69). There is also definite indication of more than one incoming mass—Dr. Nininger believes that the fall was of a large mass with satellites and not a swarm.

The 48 pages of illustrations, including some aerial views, form a valuable section of the book. Many photographs are of the specimens collected in or around the crater. The list for further reference is compiled largely from Brown's *A Bibliography on Meteorites.* Altogether, Dr. Nininger has done a fine job on a most interesting subject.

N. E. WAGMAN
Allegheny Observatory

SCIENTIFIC USES OF EARTH SATELLITES

James A. Van Allen, editor. University of Michigan Press, Ann Arbor, 1956. 316 pages. $10.00.

THIS VOLUME is a compilation of 33 papers presented at a meeting of the Upper Atmosphere Rocket Research Panel in Ann Arbor on January 26-27, 1956. The papers are of a technical or semitechnical nature. They fall in several broad areas, including perturbations of the satellite orbit and information derivable from them, experiments for direct determination of atmospheric densities, meteorological and heat transfer experiments, ultraviolet observations, cosmic ray observations, geomagnetic phenomena, ionosphere and radio propagation experiments, and investigations of micrometeorites and interplanetary dust. Several of the papers are concerned with the engineering details of a satellite itself rather than proposed experiments.

As must be true for such a volume, many of the papers describing specific apparatus to perform experiments are of a rather preliminary nature. At the time of writing, it was quite uncertain whether "solar batteries" might be useful as power sources or whether the principal temperature problem might be with components getting too hot or too cold. Some desirable features for one set of experiments are undesirable for another. For example, photocell scanning and meteorological observations need a spinning satellite, while an accelerometer method for determining atmospheric drag works best if the satellite does not spin. A Langmuir probe experiment requires a clean, conducting surface for the satellite, while considerations of eddy current damping of rotation by interaction with the geomagnetic field dictate a surface broken by nonconducting segments. Many of the proposed experiments are fascinating, but occasionally repetitious. Several of the papers in the volume are of only transient interest, a point recognized in the preface.

It is the reviewer's opinion that an important opportunity exists for useful communication with the science-minded laity

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APPLIED OPTICS AND OPTICAL DESIGN, by A. Conrady................$2.95

Write for free list. Out-of-print books located in a special search service. Books on telescope making and optical glass working. All books advertised and reviewed in Sky and Telescope.

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NEW ADDRESS: 69-11 229th Street, Oakland Gardens 64, New York

in ½ hour assemble your own
12" Sky Master

functional globe 3-color kit

The most practical way *really* to learn **WHAT** can be seen in the sky, and **WHEN,** and **WHERE** — at a glance!

The Sky Master "functional globe" shows all 88 constellations *(with mythological pictures, as shown, if wanted);* all stars to magnitude 5.5; nebulae; galactic and ecliptic poles; all 57 navigation stars with official numbers, star symbols, and geometrical diagrams.

Invaluable for students of General Astronomy, and of Marine and Air Navigation, as co-ordinates are given in RAH, SHA, *and* LHA.

Inclusive "Guide and Check Lists"

Guide: a complete, accurate, up-to-date, short course in descriptive and positional astronomy.

Main List: 550 entries in 21 columns, with both 1960 RAH and SHA co-ordinates. All stars to magnitude 3.5; multiple and variable stars; star colors and distances; nebulae, radiants, and other observational data.

15 Cross-Check Lists for immediately locating objects in the sky at any time, from RAH and LHA-on-meridian table with sunrise, sunset and twilight columns. Alphabetical lists of constellations and 190 named stars; 108 brightest stars; 50 largest stars; Messier objects and NGC-number cross lists; planetary position and solar system data; and more.

12" globe kit (with Guide and Lists) $4.95
Guide and Check Lists, separately .. 1.25
12" globe (assembled, with stand) ... 12.00
24" globe for schools; prices upon request.

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For every astronomical interest . . .

THE

HISTORY

OF THE

TELESCOPE

by Henry C. King

The book is excellent, and the illustrations numerous and luxurious.[1] (Dr. King) has succeeded in collecting and in presenting very lucidly an essentially complete account of the development of the telescope from its uncertain earliest beginnings to the 200-inch.[2] For the professional astronomer it has all the important facts of the world's great telescopes, the excellent index and the important references to the original papers. For the general reader it has an inspiring story of human progress. For the amateur telescope maker it will be an unending source of ideas.[3] Everyone who is interested in the history of the telescope is indebted to King for writing such a fine book . . . .[4]

456 pages; 103 halftones, 41 drawings, plus 52 diagrams. Extensive list of references with each chapter. **$12.50**

[1]E. Opik, *Irish Astronomical Journal.*
[2]Harlan J. Smith, *American Scientist.*
[3]John F. Heard, RASC *Journal.*
[4]Frank K. Edmondson, *Science.*

Eastern Hemisphere Publishers: Chas. Griffin, London

Other Sky Publications

MAKING YOUR OWN TELESCOPE, by Allyn J. Thompson. How to construct a low-cost 6-inch reflecting telescope. **$4.00**

VISTAS IN ASTRONOMY. Edited by Arthur Beer. Two volumes on contemporary astronomy. **Vol. 1, $28.00; Vol. 2, $44.00**

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THE STORY OF COSMIC RAYS, by Dr. W. F. G. Swann, Bartol Research Foundation. **75c**

RELATIVITY AND ITS ASTRONOMICAL IMPLICATIONS, by Dr. Philipp Frank. **75c**

Sent postpaid. Include check or money order.

SKY PUBLISHING CORPORATION
Harvard Observatory, Cambridge 38, Mass.

through the widespread interest accorded this project. Few articles have appeared in the public press describing the scientific purposes of earth satellites. To many people, the importance and excitement associated with the project lie only in the establishment of a satellite. Nonmathematical and interestingly written descriptions of what may be expected from earth satellites might well be based on the contents of this book.

The individual papers contain useful figures and diagrams, and have adequate references to the literature. The price probably is justified by the numerous diagrams and equations, along with a relatively restricted sales potential.

ALBERT P. LINNELL
Amherst College Observatory

EINFUHRUNG IN DIE OPTIK DER ATMOSPHARE

Gerhard Dietze. Akademische Verlagsgesellschaft, Sternwartenstrasse 8, Leipzig C1, East Germany, 1957. 263 pages. DM 29.

REPORTS from the American party now wintering at the South Pole tell of the beautiful atmospheric optical phenomena seen there during the antarctic fall, before the sun sank below the horizon. They very frequently could watch solar halos, mock suns, vertical pillars and horizontal circles of light through the sun, and many other less familiar but equally striking effects. On the south polar plateau and on the Greenland icecap, these appearances are perhaps more frequent than anywhere else on earth, because of local conditions that tend to fill the air with tiny ice crystals.

Even in more familiar parts of the world, these optical phenomena are visible often enough to provide a fascinating field of study by the amateur scientist.

For a first introduction to the subject, there are excellent descriptions in M. Minnaert's *The Nature of Light and Colour in the Open Air,* reviewed on page 385 of the September, 1954, issue. Those who would like to supplement this by a somewhat more detailed treatment will find Dr. Dietze's new book of value.

Actually, his *Introduction to the Optics of the Atmosphere* covers much more than halo phenomena. There is a chapter on refraction of light in the atmosphere, which deals with astronomical refraction, mirages, and the green ray. Rainbows, aureoles, and glories are described, and there are sections on the distribution of brightness over the day and night sky, twilight colors, atmospheric extinction, and sky polarization. There is also an extended account of scattering in the atmosphere, which outlines the ideas of Chandrasekhar.

While Dr. Dietze's book makes some use of mathematics, it is not an advanced treatise, and should be understandable to anyone who has some acquaintance with optics and who reads German. There are many compact tables of numerical data, such as the one on page 155 that specifies the illumination produced by the moon at different phases and different elevations above the horizon.

There are several beautiful color photographs of atmospheric phenomena. One unusual picture is of a 22-degree solar halo, reflected from a convex mirror to widen the field. Thus the photographer himself appears in the picture, together with a ski held aloft by his companion to hide the direct glare of the sun.

J. A.

NEW BOOKS RECEIVED

VISTAS IN ASTRONOMY, Vol. 2, *Arthur Beer,* editor, 1956, *Sky Publishing Corp.* 994 pages. $44.00.

Appearing a year after the first volume, the second half of this monumental work presents the remaining 99 of the 215 original essays by astronomers of many countries. This volume deals with solar-terrestrial relations, geophysics, the planetary system, stellar astronomy, photometry, spectroscopy, stars with peculiar spectra, novae, galaxies, cosmogony and cosmology. Included also are the name and subject indexes for both volumes. Volume 1 was reviewed in *Sky and Telescope* for May, 1956.

MODERN APPLIED PHOTOGRAPHY, *G. A. Jones,* 1957, *Philosophical Library.* 162 pages. $4.75.

A prominent British expert tells in popular language about current uses of photography in science and industry.

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Each lens is thoroughly tested by us and is guaranteed to resolve two seconds of arc or better. They are corrected for the C and F lines, as is usual for visual refractors. The zonal spherical aberration and the chromatic variation of spherical aberration are negligible. The cell is machined to close tolerances so that it will fit directly over our standard aluminum tubing, eliminating any mounting problems.

3¼" diam., 48" f.l. (uncoated).. **$28.00**
Same as above with coating.... **$32.00**
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Same as above with coating.... **$69.00**

We can supply ALUMINUM TUBING for the above lenses.

"BIG" ACHROMATIC TELESCOPE OBJECTIVES

We have the largest selection of diameters and focal lengths in the United States available for immediate delivery. These are perfect magnesium-fluoride coated and cemented Gov't. surplus lenses made of finest crown and flint optical glass. Not mounted. Fully corrected. Tremendous resolving power. They can readily be used with eyepieces of only ¼" focal length, thereby producing high powers. Guaranteed well suited for astronomical telescopes, spotting scopes, and other instruments. Gov't. cost up to $100.

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54 mm (2⅛")	254 mm (10")	**$12.50**	83 mm (3¼")	660 mm (26")	**$28.00**
54 mm (2⅛")	300 mm (11.8")	**12.50**	83 mm (3¼")	711 mm (28")	**28.00**
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54 mm (2⅛")	390 mm (15.4")	**9.75**	83 mm (3¼")	876 mm (34½")	**28.00**
54 mm (2⅛")	508 mm (20")	**12.50**	83 mm (3¼")	1016 mm (40")	**30.00**
54 mm (2⅛")	600 mm (23½")	**12.50**	102 mm (4")	876 mm (34½")	**60.00**
54 mm (2⅛")	762 mm (30")	**12.50**	108 mm (4¼")	914 mm (36")	**60.00**
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78 mm (3$\frac{1}{16}$")	381 mm (15")	**21.00**	128 mm (5$\frac{1}{16}$")*	628 mm (24¾")	**75.00**
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81 mm (3$\frac{3}{16}$")	622 mm (24½")	**22.50**	*Not coated		

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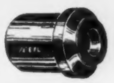
MOUNTED EYEPIECES



The buy of a lifetime at a great saving. Perfect war-surplus lenses set in black anodized standard aluminum 1¼" O.D. mounts.

F.L.	TYPE	PRICE
12.5 mm (½")	Symmetrical	**$ 6.00**
16 mm (⅝")	Erfle (wide angle)	**12.50**
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32 mm (1¼")	Orthoscopic	**12.50**
35 mm (1⅜")	Symmetrical	**8.00**
55 mm (2$\frac{3}{16}$")	Kellner	**6.00**

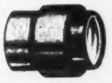
COATED 75 cents extra.

ASTRONOMICAL MIRRORS

These mirrors are of the highest quality, polished to ¼-wave accuracy. They are aluminized, and have a silicon monoxide protective coating. You will be pleased with their performance.

	Diam.	F.L.	Postpaid
Plate Glass	3$\frac{3}{16}$"	42"	**$ 9.75**
Pyrex	4¼"	45"	**$13.50**
Pyrex	6"	60"	**$25.00**

AN ECONOMICAL EYEPIECE



This mounted eyepiece has two magnesium-fluoride coated lenses 29 mm in diameter. It is designed to give good eye relief. It has an effective focal length of 1¼" (8x).

The eyepiece cell fits a 1¼" tube.......... **$4.50**

Aluminum Telescope Tubing

O.D.	I.D.	Price Per Ft.
2¼"	2⅛"	**$1.20**
3⅜"	3¼"	**1.75**
4½"	4⅜"	**2.75**
5"	4⅞"	**2.75**

All tubing is shipped POSTPAID.

Focusing Eyepiece Mounts Rack & Pinion Type

The aluminum body casting is finished in black crackle paint and is machined to fit all our aluminum tubing. Has a chrome-plated brass focusing tube, which accommodates standard 1¼" eyepieces.

For 2⅛" I.D. Tubing	Postpaid	**$12.95**
For 3¼" I.D. Tubing	"	**12.95**
For 4⅜" I.D. Tubing	"	**12.95**

REFLECTOR TYPE FOR ALL SIZE TUBING: Complete with diagonal holder........ **$ 9.95**

Aluminum Lens Cells Black Anodized

Cell for Lenses	Cell Fits Tubing	Price
54 mm Diam.	2⅛" I.D.	**$ 3.50**
78 mm "	3¼" "	**6.50**
81 mm "	3¼" "	**6.50**
83 mm "	3¼" "	**6.50**
110 mm "	4⅜" "	**10.50**

COATED BINOCULARS

American Type

"Zeiss" Type

Beautiful imported binoculars, precision made, at a low, low price. Above we have pictured the two most popular types. The American type offers a superior one-piece frame and a clean design, pleasing to the eye. Complete with carrying case and straps. **Price plus 10% Federal tax.**

SIZE	TYPE	C. FOCUS	IND. FOCUS
6 x 15	OPERA	—	**$12.75**
6 x 30	"ZEISS"	**$18.75**	**16.75**
7 x 35	"ZEISS"	**21.25**	**19.25**
7 x 35	AMERICAN	**23.50**	—
7 x 35	AMERICAN WIDE ANGLE 10°	**37.50**	—
7 x 50	"ZEISS"	**24.95**	**22.50**
7 x 50	AMERICAN	**32.50**	—
8 x 30	"ZEISS"	**21.00**	**18.25**
10 x 50	"ZEISS"	**30.75**	**28.50**
20 x 50	"ZEISS"	**41.50**	**39.50**

MONOCULARS

Brand new, coated optics, complete with pigskin case and neck straps.

	Price		Price
6 x 30	**$10.00**	7 x 50	**$15.00**
8 x 30	**11.25**	16 x 50	**17.50**
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"MILLIONS" of Lenses, etc. Free Catalogue

We pay the POSTAGE — C.O.D.'s you pay postage. Satisfaction guaranteed or money refunded if merchandise returned within 30 days.

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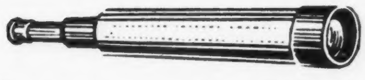
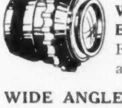


40 power Special Price **$57.50**

You rarely find an instrument like this offered at so low a price. Here is another example of American ingenuity. Big 3" diameter achromatic coated objective which will give needle-sharp crystal-clear images. Focusing is a delight with the micrometer spiral focusing drawtube. Light-weight aluminum construction throughout, black crackle finish, length open 22 inches, closed 17 inches. This telescope gives an upright image—it is WONDERFUL for astronomy, SUPERB for long distances, EXCELLENT as a spotting scope.

"GIANT" EYEPIECE



WIDE ANGLE ERFLE (68° Field) **EYEPIECE.** Brand new, coated, 1¼" E.F.L. Focusing mount. 3 perfect achromats, 1$\frac{13}{16}$" aperture. **$12.50**

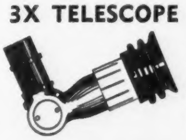
WIDE ANGLE ERFLE 1½" E.F.L. Brand new; contains Eastman Kodak's rare-earth glasses; aperture 2"; focusing mounts; 65° field... **$18.50**

1¼" Diam. Adapter for above eyepieces. **$3.95**

LENS CLEANING TISSUE — Here is a wonderful Gov't. surplus buy of Lens Paper which was made to the highest Gov't. standards and specifications.

500 sheets size 7½" x 11".................. **$1.00**

3X TELESCOPE



Makes a nice low-priced finder. Brand new; has 1" Achromatic Objective. Amici Prism Erecting System, 1⅜" Achromatic Eye and Field Lens. Small, compact, wt. 2 lbs.

Gov't. Cost $200. **$9.75**

FIRST-SURFACE MIRRORS

Size	Thickness	Postpaid
14" x 16"	¼"	**$10.00**
8" x 10"	¼"	**4.25**
4" x 5"	¼"	**1.85**
4" x 4"	¼"	**1.50**
1¼" x 1½"	$\frac{1}{16}$"	**.25**

RIGHT-ANGLE PRISMS

8 mm face.....ea.	**$ .75**	28 mm face.....ea.	**$1.75**
12 mm face.....ea.	**.75**	38 mm face.....ea.	**2.00**
23 mm face.....ea.	**1.25**	47 mm face.....ea.	**3.00**

A. JAEGERS

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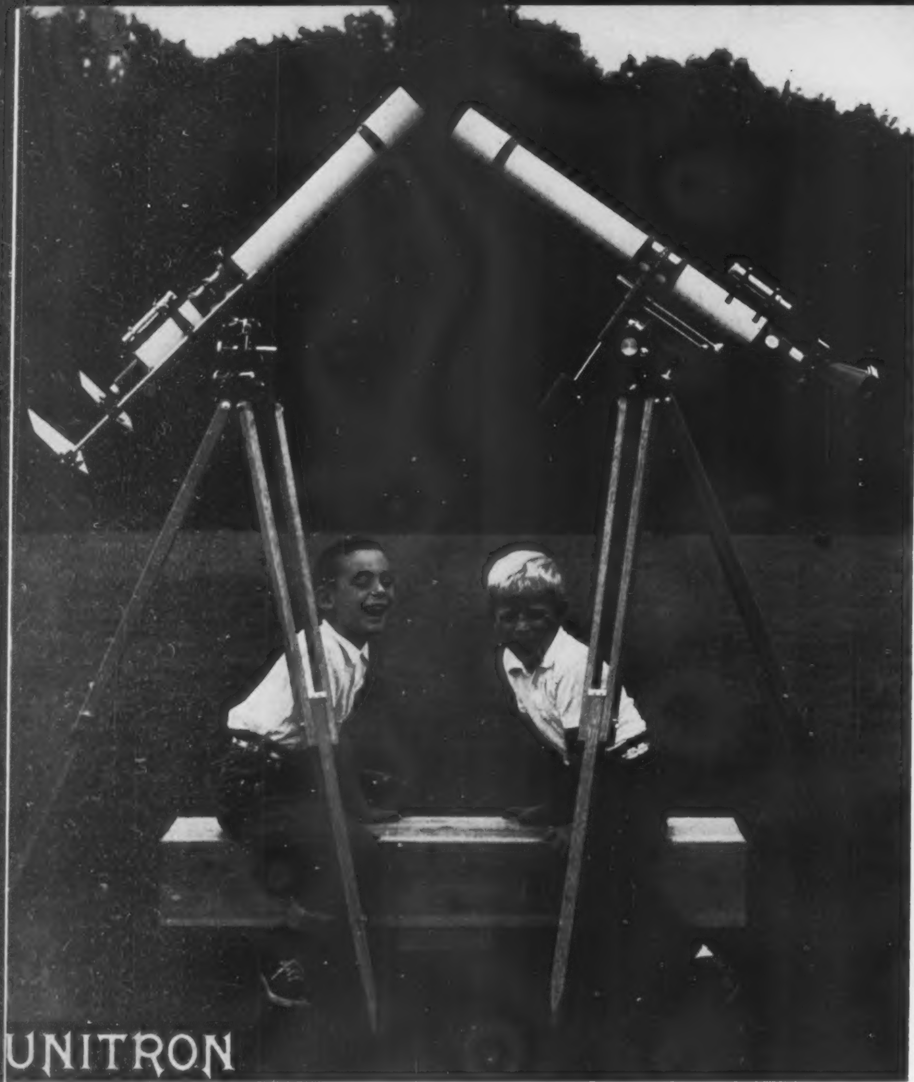
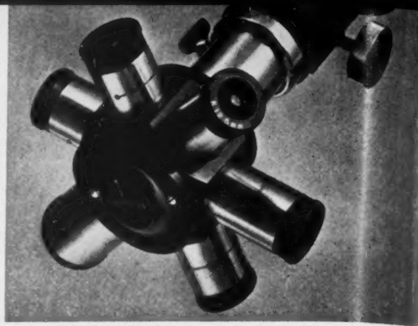
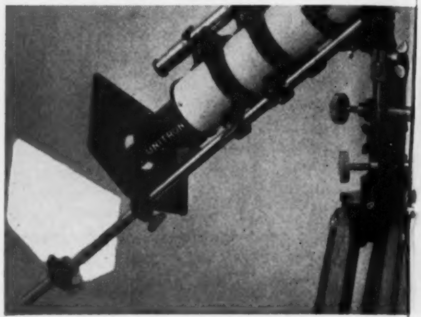


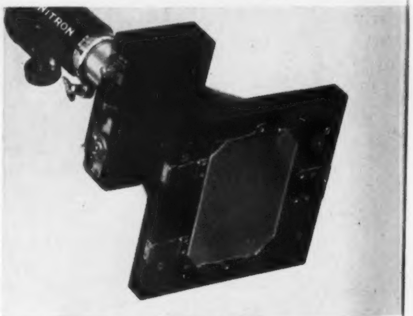


Six magnifications at your fingertips with the UNIHEX Rotary Eyepiece Selector.

With the DUETRON Double Eyepiece, two observers may use the UNITRON together.



The Sun Projecting Screen permits group observation and accurate charting of sunspots.



With Astro-Camera 220, it's easy to photograph the sun, sunspots, the moon, and eclipses.

Use the Erecting Prism System for real closeup views of distant terrestrial objects.

A UNITRON is *Versatile* . . . Look at all you can do with a UNITRON 2.4-inch Refractor!

It is hardly surprising that UNITRON owners never tire of using their instruments. For with the exclusive UNITRON features and accessories, a UNITRON is truly the "all-purpose" telescope which instantly adapts to suit your observing mood. This versatility is found in even our popularly priced 2.4" models pictured above.

Optically speaking, these highly portable UNITRON Refractors duplicate the performance of larger, unwieldy telescopes of other types. With the long focal length, higher magnifications of planetary and lunar images are obtained with low-power eyepieces. Moreover, there are no mirrored surfaces to become oxidized, no secondary optics to cause diffraction patterns, and no folding of the light back on itself with consequent loss of definition. No wonder then that you can **see** more and **do** more with a UNITRON.

See the back cover.

Both 2.4" models come complete with tripod and mounting, eyepieces, view finder, sunglass, choice of UNIHEX Rotary Eyepiece Selector or erecting prism system and star diagonal, and cabinets for tube and tripod.

Model 114 with altazimuth mounting and slow-motion controls for both altitude and azimuth, eyepieces for 100x, 72x, 50x, 35x. ($12.50 down)

$125

Model 128 with equatorial mounting and slow-motion controls for both declination and right ascension, eyepieces for 129x, 100x, 72x, 50x, 35x. ($22.50 down)

$225

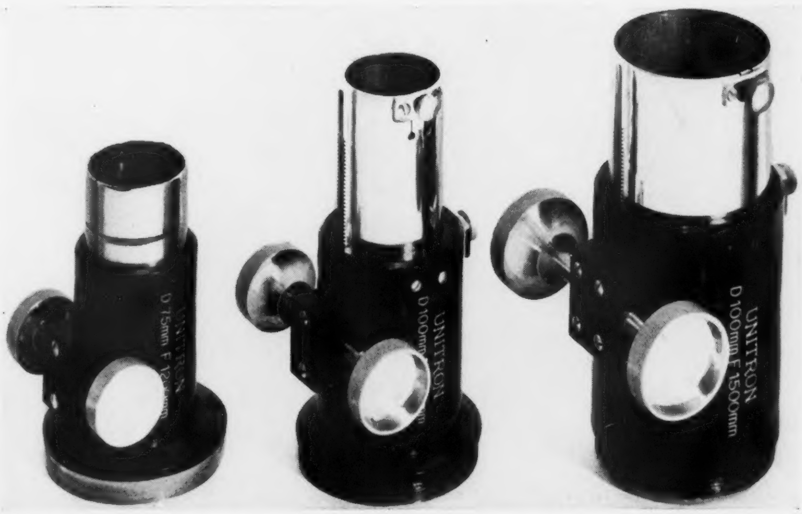
PRICE LIST OF ACCESSORIES

UNIHEX Rotary Eyepiece Selector	$24.75
DUETRON Double Eyepiece	23.50
Sun Projecting Screen with UNICLAMPS	12.75
Astro-Camera 220 with accessories	69.50
Erecting Prism System	18.50
4-mm. (225x) Orthoscopic Eyepiece	14.75
5-mm. (180x) Orthoscopic Eyepiece	14.75
6-mm. (150x) Orthoscopic Eyepiece	14.75
7-mm. (129x) Achromatized Symmetrical Eyepiece	9.75
40-mm. (22x) Kellner Eyepiece	14.75

UNITRON INSTRUMENT DIVISION of UNITED SCIENTIFIC CO.
204-206 MILK STREET BOSTON 9, MASSACHUSETTS

Telescope Accessories by UNITRON

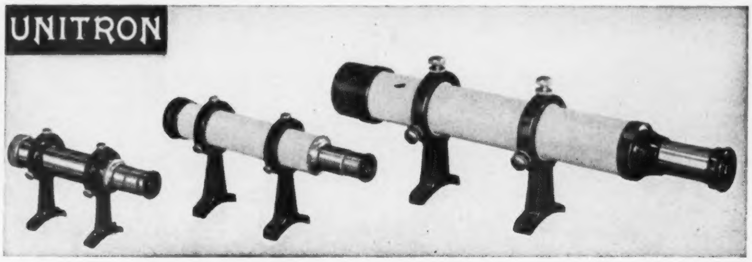
UNITRON Telescope Accessories and Components are all standard equipment in UNITRON Refractors and are therefore of the finest quality obtainable. Items available include objective lenses, eyepieces, view finders, sun projecting screens, star diagonals, and the famous UNIHEX and DUETRON. All are illustrated, described, and priced in the UNITRON Catalog.



RACK-AND-PINION FOCUSING MECHANISMS: Shown above, left to right, **Standard, De Luxe,** and **Super** Models. Prices include long drawtubes with eyepiece holders for both 24.5-mm. and $1\frac{1}{4}$" O.D. eyepieces. The Super model can, in addition, hold our giant 60-mm. f.l., 58-mm. O.D. eyepiece. The Super and De Luxe Models have locks for both the drawtube and focusing sleeve. Shipped postpaid.

Standard Model............ **Only $12.50**
De Luxe Model............ **Only $28.50**
Super Model............... **Only $44.50**

Couplings have outside diameter $2\frac{9}{16}$". For the above with coupling to fit $3\frac{1}{16}$" I.D. tubing, add $3.00. For heavy coupling (which also acts as a counterbalance) for $4\frac{3}{8}$" O.D. tubing, add $9.50.



L. to R.: (1) 23.5-mm. 6x finder; (2) 30-mm. 8x finder; (3) 42-mm. 10x finder

1. **VIEW FINDER** (As used on UNITRON 2.4" Equatorial): 23.5-mm. (.93") achromatic objective, 6x eyepiece with crosshairs. Chromed brass tube. Mounting brackets with centering screws.

Only $8.50 postpaid

2. **VIEW FINDER** (As used on UNITRON 3" Refractors): 30-mm. (1.2") coated achromatic objective and 8x eyepiece with crosshairs. Other details as in View Finder 3.

Only $10.75 postpaid

SUN PROJECTING SCREEN APPARATUS: White metal screen with matching black metal shade. Chromed brass extension rod with mounting brackets.

Set with screen 6" x 6" **Only $13.50 postpaid**
Set with screen 7" x 7" **Only $15.75 postpaid**

3. **VIEW FINDER** (As used on UNITRON 4" Refractors): 42-mm. (1.6") coated achromatic air-spaced objective. 10x eyepiece with crosshairs. Duraluminum tube finished in white enamel. Dewcap. Furnished with mounting brackets with centering screws for collimation. This finder also makes an excellent hand telescope for spectacular wide-field views of the sky.

Only $18.00 postpaid

EQUATORIAL MOUNTING and TRIPOD: Complete with slow-motion controls for both declination and right ascension, setting circles and verniers, and many other features.

As used on UNITRON 3" Refractor **$198**
As used on UNITRON 4" Refractor **$370**

(These prices are f.o.b. Boston)

UNITRON INSTRUMENT DIVISION OF UNITED SCIENTIFIC COMPANY
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MANY UNITRON MODELS TO CHOOSE FROM

1.6" ALTAZIMUTH ($7.50 Down) **$75**
with eyepieces for 78x, 56x, 39x

2.4" ALTAZIMUTH ($12.50 Down) **$125**
with eyepieces for 100x, 72x, 50x, 35x

2.4" EQUATORIAL ($22.50 Down) **$225**
with eyepieces for 129x, 100x, 72x, 50x, 35x

3" ALTAZIMUTH ($26.50 Down) **$265**
with eyepieces for 171x, 131x, 96x, 67x, 48x

3" EQUATORIAL ($43.50 Down) **$435**
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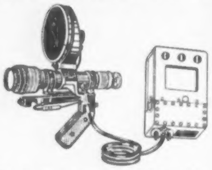

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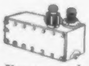

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A Porter-type Grinding Machine

HAND WORKING a first mirror is valuable experience, but many an amateur telescope maker who goes further soon wants to build a grinding machine. If you are handy with tools, a machine similar to that shown below can be constructed in the cellar workshop from odds and ends for as little as $25.

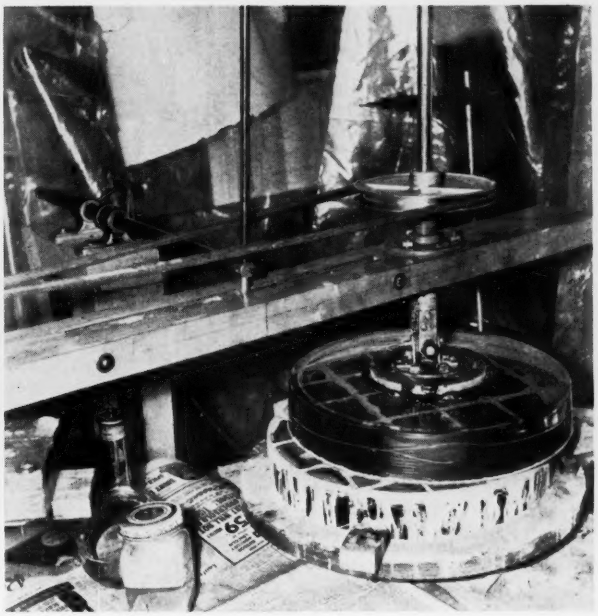
Scrap lumber was used for the frame of the machine, which is driven by an old ¼-horsepower, 1,475-r.p.m. washing-machine motor. A belt transmission turns the large pulley above the motor, giving a 6:1 reduction in speed. This pulley is connected with a 64-tooth washing-machine worm system, whose large gear is visible just to the left of the pulley. The output shaft of the gear turns at 8 r.p.m., and a series of other pulleys on this shaft allows the operator to choose the speeds of the rotating table carrying the work and of the eccentric driving arm. Rates of 2 r.p.m. for the turntable and 32 r.p.m. for the driving arm seem to work best for me.

In my machine, a critical point is the pulley drive on the crank-arm shaft, underneath the main table; the friction of the V-belt must be carefully adjusted. If this part of the machine were to be rebuilt, I would use a gear drive instead.

The second picture is a closeup of the driving arm. As the shaft through the table rotates, it causes the upper shaft to trace out a cylinder, forcing the horizontal arm to move back and forth. The length of this stroke is controlled by the position of the upper shaft; the nearer this is to the (imaginary) prolongation of the lower shaft, the shorter the stroke. On this upper shaft is a pulley which carries the belt that rotates the mirror.

In the third photograph we see the other end of the driving arm and the mirror drive. The direction of the mirror's rotation is easily reversed by taking the twist out of the belt that drives the vertical axis. A metal plate is pitch-fastened to the back of the mirror, and this plate is supported by a homemade universal joint, with two horizontal pivots at right angles to each other, thus allowing the mirror to rock freely in all directions as it traverses the tool.

R. R. Broadfoot's homemade machine for grinding and polishing mirrors cost less than $25. The driving arm is hardwood, and the turntable is ¾" plywood, well shellacked. The photographs with this article are by the author.



Left: This closeup shows the eccentric-arm arrangement for controlling the length of stroke.

Right: The mirror end of the stroke arm, with the pulley drive that rotates the mirror. The latter's central perforation can be seen through the glass.

On the driving arm to the left of the mirror shaft is a slot in which has been inserted an upright metal rod. The latter is held by a second rod extending toward the back of the machine. This horizontal rod passes through two mounted guides, one with a locking bolt. The setting of the horizontal rod determines the amount of side motion in the driving arm's stroke—a very important adjustment.

I built this machine to complete the polishing and figuring of the $12\frac{1}{2}$-inch, f/5 mirror shown on the machine. It had been ground by hand before the machine was finished. As this mirror is to be used in a Cassegrainian telescope, it has a central perforation $2\frac{1}{2}''$ in diameter, cut through from the back to within $\frac{1}{16}''$ of the front surface.

In polishing this mirror, I approached the problem from the point of view of duplicating hand work by machine action. I began by adjusting the driving arm and side throw to give a $\frac{1}{3}$-diameter stroke, and when polishing was about three-fourths accomplished this was altered to a $\frac{1}{6}$-diameter stroke. Small changes in length of stroke were made to avoid patterns being polished into the glass.

To correct zones, I adjusted stroke and side throw to bring the area being worked to the edge of the tool. Following the same principle for parabolization, the central part of the mirror was brought over the edge of the tool. This was the first mirror processed on my machine; further experiments should improve the methods used and cut down correction time.

It is often hard to keep a basement workshop as clean as a precision polishing room. My inexpensive but effective method is to enclose the machine area completely with polyethylene sheeting.

In planning this machine, I received valuable advice from G. Longworth, David Dunlap Observatory, University of Toronto.

R. R. BROADFOOT
763 Mt. Pleasant Rd.
Toronto 7, Canada

ED. NOTE: The Porter type of grinding machine is a variant of the famous Draper model. In the Draper machine the side throw is accomplished at the end of the driving arm beyond the mirror, and the resulting stroke is elliptical. The Porter machine gives a crescent-shaped stroke instead of a true elliptical one. Examples of these and other machines can be found in *Amateur Telescope Making—Book I*, pages 162-64. Many workers prefer to have a larger number of variations in the rate of rotation of the turntable and driving arm than Mr. Broadfoot has. In *Scientific American*, July, 1947, page 47, Dave Broadhead describes his Draper-type grinding machine with nine speeds.

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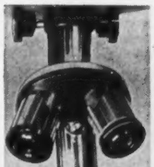

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Gear Trains for Telescope Drives and Sidereal Clocks

PRECISION DRIVES are practically a necessity for telescopes with which fine star photographs are to be taken, even for guided exposures. And the visual observer will find a good driving rate a great convenience. My purpose in this article is to suggest appropriate gear-train ratios for telescopes and sidereal clocks.

More than half a century ago, at Harvard Observatory, E. S. King showed that it is desirable to rotate the polar axle of a telescope a little more slowly than the sidereal rate, in order to compensate for the effects of atmospheric refraction. The desired rate depends on the hour angle and declination of the star as well as the latitude of the observatory. After considering all the factors involved, Professor King recommended that the best average rate would be about one second per hour slower than true sidereal time.

Most telescope makers plan to drive their instruments with synchronous motors, the output shaft of one of these usually making one revolution per minute (1 r.p.m.). The problem is to gear this rate down to one revolution of the polar axle in about 24 seconds less than a sidereal day, which is 23 hours, 56 minutes, 4.09 seconds long. There are a number of suitable combinations of gears that will make the conversion, but it is not well known that some of these require only standard and readily obtainable gears.

The meaning of the ratios is best seen in the diagram that has been drawn for train **A** of my list, to drive the polar axle at a losing rate of 1.01 seconds per sidereal hour. In the accompanying list of gear trains, the driving gears are in the numerators and the driven gears are in the denominators. *Pitch* is the number of teeth on the circumference of a gear one inch in diameter, and describes the meshing size of the teeth. The *pitch diameter* is found by dividing the number of teeth by the pitch; a 56-tooth gear of 32 pitch is 56/32 or 1.75" pitch diameter.

All the gears of trains **A** and **B** are standard and are listed by Boston Gear Works and other firms. If the direction of rotation turns out to be wrong, the motor can be changed end for end, an idler gear inserted anywhere in the train, or the motor connections rewired.

Slightly Slower than Sidereal Rate

A $1 \text{ r.p.m.} \times \frac{20}{66} \times \frac{14}{56} \times \frac{34}{37} \times \frac{1}{100}$

B $1 \text{ r.p.m.} \times \frac{16}{52} \times \frac{20}{52} \times \frac{20}{34} \times \frac{1}{100}$

C $1 \text{ r.p.m.} \times \frac{10}{65} \times \frac{1}{221}$

D $1 \text{ r.p.m.} \times \frac{10}{85} \times \frac{1}{169}$

Provision for Lunar Rate

E $1 \text{ r.p.m.} \times \frac{20}{56} \times \frac{28}{66} \times \frac{34}{74} \times \frac{1}{100}$

(For following the moon, replace 28/66 with 27/66.)

Actual Sidereal Rate

F $1 \text{ r.p.m.} \times \frac{12}{40} \times \frac{22}{58} \times \frac{41}{67} \times \frac{1}{100}$

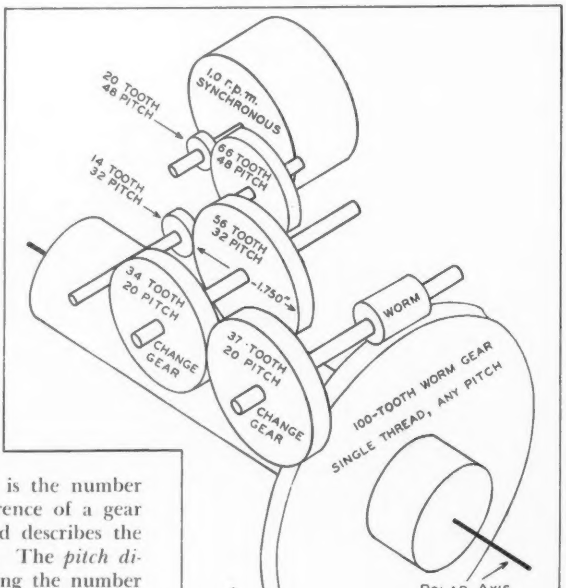
Second Hand of Sidereal Clock

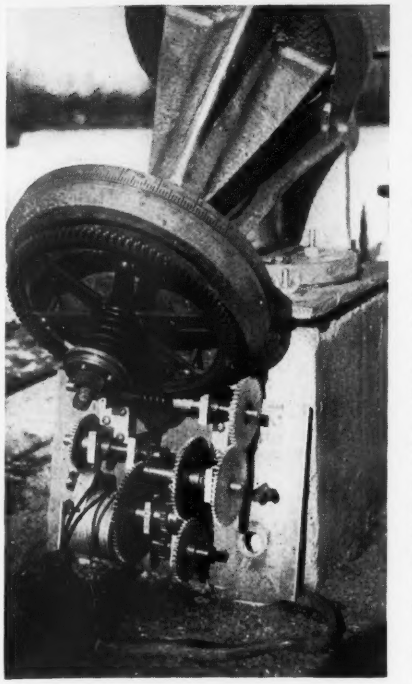
G $60 \text{ r.p.m.} \times \frac{12}{60} \times \frac{14}{66} \times \frac{26}{66}$

H $60 \text{ r.p.m.} \times \frac{12}{40} \times \frac{24}{100} \times \frac{22}{58} \times \frac{41}{67}$

Train A. This series of gears loses 1.01 seconds per hour. The 100-tooth single-thread worm gear is chosen because it has the largest number of teeth in stock sizes and is available in any pitch. This chain is reducible to the prime-number ratio $(5 \times 17)/(3 \times 11 \times 37) \times 1/100$, and is related to one given by Paul B. Sweger

The arrangement of gears in train "A" is illustrated here. There is no clutch shown, however, the connection from motor to polar axis being direct. When a telescope is driven by a 1-r.p.m. synchronous motor through this train, good long-exposure photographs of star fields may be made without guiding.





With war-surplus parts and a 100-tooth 16-pitch bronze worm gear, Owen Gingerich built this drive that loses about 26 seconds in a sidereal day, almost the same as Mr. Everhart's train "B."

(*Sky and Telescope,* August, 1955, page 429).

Train B. This series loses 1.08 seconds per hour, or nearly 26 seconds per day, and in practice is as useful as **A**. Its spur gears are standard in 32 pitch, except those in the last pair (20/34), which are obtainable as 20-pitch change gears.

Train C. When reduced to its simplest form, **B** can be rewritten as $2/(13 \times 13 \times 17)$. This was noted by Roland Bourne, who in 1947 described a drive requiring a 13×17 or 221-tooth worm gear.

Train D. This is an alternative version of **B** suggested by Mr. Sweger (February, 1950, issue, page 93), requiring a 13×13 or 169-tooth worm gear. **C** and **D** are among the simplest combinations, provided one wishes to make or order some rather special gears.

Train E. With a variation of **A**, losing 1.01 seconds per hour, the gears are arranged so that one of 28 teeth can be replaced by one of 27 teeth. The train is here given with the first two gears (20/56) of 32 pitch and the rest 20-pitch change gears. To make a "moon gearshift" it is only necessary to shift a 27-tooth change gear in place of the 28-tooth gear; the telescope will then follow the moon. This substitution, with slightly different gears, is mentioned by Owen Gingerich in his article on telescope drives in the October, 1954, *Sky and Telescope,* page 433.

Train F. For those observers who prefer to run their telescopes at the precise sidereal rate, despite atmospheric refraction, this chain will operate the telescope with an error of only 0.01 second per sidereal day. The series reduces to $(3 \times 11 \times 41)/(2 \times 5 \times 29 \times 67) \times 1/100$, and is the most exact of over a thousand ratios tested by the writer.

Train G. Here we have quite a different application: a clock to indicate sidereal time with good precision. To drive the second hand at one revolution per sidereal minute we may start with a 60-r.p.m. synchronous motor. The conversion factor required is $366.2422/(365.2422 \times 60)$, which can be closely approximated by train **G**. The cumulative error is 1.46 seconds gain per day.

This series is related to one given by D. F. Brocchi in 1940, and has the advantage that all the gears are small, being obtainable in 48-pitch brass. To see how the minute hand and the hour hand may be driven at 1/60 and $1/60 \times 24$ times this rate, respectively, it is suggested that the reader take apart any expendable clock.

Train H. This series (based on **F**) is considerably more exact than **G** and will turn the second hand of a clock with a gain of only 0.01 second per day, less than four seconds per year. The first two pairs of gears are standard 48 pitch; the others are 20-pitch change gears.

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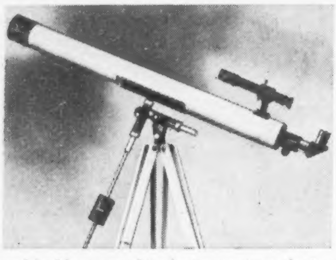

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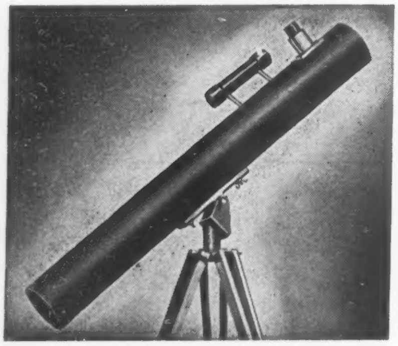

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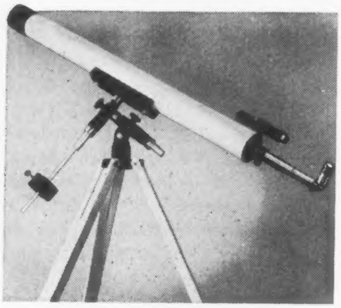
SPITZ MOONSCOPE

A precision-made 32-power reflecting telescope—by makers of Spitz Jr. Planetarium. Clearly reveals the craters of the moon, shows moons of Jupiter, other wonders of the heavens. Based on same principles as world's giant telescopes. Stands 36" high on removable legs. Adjustable 3" polished and corrected mirror. Fork-type altazimuth mount rotates on full 360° circle — swings to any location in the sky. Fascinating 18-page instruction book; sturdy carrying case.

Stock #70,068-Y .... **$14.95 ppd.**

4" REFRACTOR TELESCOPE

240-POWER



Complete with Finder, Equatorial Mounting, Tripod, Eyepiece Extension, Star Diagonal, and Three Eyepieces

Our newest development. Built for rugged use, quality performance. Mounting made from heavy iron castings with machined bearings for smooth operation. Tripod has extra-heavy 60" hardwood legs. Telescope's weight is 42 lbs., giving stable, steady viewing. Big 4" objective is an air-spaced achromat, each element coated on both sides for low reflection. Three eyepieces supplied give you 48X, 120X, and 240X. Special Barlow lens also gives up to 500X. Star diagonal included for comfortable viewing at high angles. Rack-and-pinion focusing. All metal parts are plated to prevent rusting. Finder is 8 power. The usual price for a 4" refractor of comparable quality is over $400, so our new model saves you almost 40%.

Stock #85,038-Y .... **$247.00** f.o.b.
(Shipping wt. 55 lbs.) Barrington, N. J.

SILICON POLISHING AND CLEANING CLOTHS

Modern research produced this amazing new product. These cloths combine the miracle of silicones with a nonwoven, all-rayon cloth. They will dust, polish, and protect mirrors, reflectors, lenses, coated optics, crystal glass, plexiglass, lucite, and many other plastics. Vastly superior to diaper rags, cheesecloth, lens tissue. These are the only cloths that will not scratch any polished or smooth surface. They are lintless, nonoily, and nongreasy. Anti-fogging of glass is another benefit from their use. Cloths are 18" x 16".

Stock #60,059-Y .... **Package of 3 cloths $1.00 ppd.**

Stock #70,137-Y .... **Package of 100 cloths $26.50 ppd.**

Lower prices on larger quantities

LAST MINUTE FLASH! JUST RECEIVED!

War-surplus infrared telescope items—including IP25 image tubes, power-packs, infrared filters, and complete telescopes. See without being seen . . . convert infrared rays to visible image. Tremendous advances being made in use of infrared in research and development. Priced at fraction of Gov't. cost.

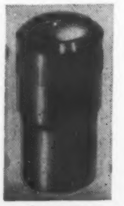
Write for Bulletin #A-26Y

ROTATING STAR CHART

Planisphere with a rotating chart shows well over 500 stars in the heavens and their relationships to each other at any selected day and hour. Table on reverse side supplies valuable information on constellations, navigation stars, locations of the planets according to month and year, dates of meteor showers, the zodiac, and the like.

Stock #9227-Y .... **$.50 ppd.**

WAR-SURPLUS TELESCOPE EYEPIECE



Mounted Kellner Eyepiece, Type 3. 2 achromats, F.L. 28 mm., eye relief 22 mm. An extension added, O.D. 1¼", standard for most types of telescopes. Gov't. cost $26.50.

Stock #5223-Y .... **$7.95 ppd.**

EDSCORP SATELLITE TELESCOPE

THE STORY: From the beginning of the visual satellite program, Edmund Scientific Co. was consulted by the Coordinator of Visual Satellite Observations of the Smithsonian Astrophysical Observatory in order to find existing optical instruments or to help in the development of new ones to meet the unique requirements of MOONWATCH. Every effort was to be made to get an instrument with the greatest possible field, which would still have the ability to observe faint objects with only moderate magnification. All this was to be provided at a minimum cost. More than thirty different optical arrangements were examined and evaluated by expert advisors to the MOONWATCH program. The optics which we have used have been described in the *Bulletin for Visual Observers of Satellites* as providing one of the best combinations for the purpose.

OPTICS: The Satellite Scope has two important optical characteristics: A wide (51-mm.) diameter, low-reflection-coated objective lens. A six-element extremely wide-field, coated Erfle eyepiece that, in combination with the objective, gives 5.5 power with a big 12° field and over 7-mm. exit pupil.

MOUNT: The mount came in for special attention because of unique requirements of group observing. The center of rotation of the instrument is just below the point where the optical axis is deflected by the front-surface mirror. The mirror is set at 45° to the axis of the telescope barrel and reflects light at exactly 90°. Side brackets and wing nuts permit fast, easy elevation and rigid locking. Rubber eyeguards and the angle of the telescope permit the greatest comfort in long-time viewing. The wide field and our special mount permit the utmost coverage of the possible passage of the satellite, without omission of an area of the sky, by a string of observers.

OTHER USES FOR THE SATELLITE SCOPE

1. Makes a perfect wide-field finder. A special groove on the barrel helps in locating it in the finder mount. Fits our twin-ring finder mount, Stock No. 70,079-Y—$9.95. **2.** Use the Erfle eyepiece on your regular astronomical telescope. You will need our adapter, Stock No. 30,171-Y—$3.95, which gives you an O.D. of 1¼". This eyepiece cost the government $56.00! **3.** Makes a wonderful comet seeker; see complete asterisms. **4.** Makes a fine rich-field telescope; see wide areas of sky with deep penetration.

Especially Made for Members of MOONWATCH
Stock #70,074-Y .... **$49.50 ppd.**

ATTENTION!

Here's an Interesting "Do-It-Yourself" Project

If you want to build your own Satellite Scope, we can supply the optical parts, or any metal parts from our assembled Satellite Scope. We'll be glad to send you full description of these components together with price information.

WRITE FOR SATELLITE BULLETIN #40-Y

ASTRONOMICAL TELESCOPE TUBING

Stock No.	I.D.	O.D.	Lgth.	Description	Price
80,038-Y	4⅞"	5¼"	46"	Spiral-wound paper	$2.50
85,008-Y	6⅞"	7⅜"	60"	Spiral-wound paper	4.00
85,011-Y	2⅞"	3"	48"	Aluminum	6.00
85,012-Y	3⅞"	4"	60"	Aluminum	8.75
85,013-Y	4⅞"	5"	48"	Aluminum	9.00
85,014-Y	6⅞"	7"	60"	Aluminum	15.00

All tubing is shipped f.o.b. Barrington, N. J.

EDMUND SCIENTIFIC CO.

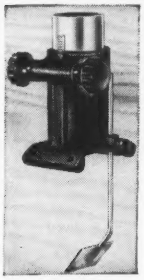
WAR-SURPLUS KELLNER EYEPIECE

Mounted — Ready to Use — 1¼" Outside Diameter — Coated — 1¼" Focal Length

Consists of an achromatic eye lens and an achromatic doublet field lens (Gov't. cost about $30). The clear aperture of the lenses is approximately 1", giving wide exit pupil and a clear image. Excellent for any telescope when low power and a wide field are needed. Try it for 10 days — if you don't agree that the performance is better than any commercial type selling for two or three times our price, we will refund your money in full.

Stock #50,130-Y .... $5.90 ppd.

Rack & Pinion Eyepiece Mounts



For Reflectors

For Refractors

Now you can improve performance in a most important part of your telescope — the eyepiece holder. Smooth, trouble-free focusing will help you to get professional performance. Look at all these fine features: real rack-and-pinion focusing with variable tension adjustment; tube accommodates standard 1¼" eyepieces and accessory equipment; lightweight aluminum body casting; focusing tube and rack of chrome-plated brass; body finished in black wrinkle paint. No. 50,077-Y is for reflecting telescopes, has focus travel of over 2", and is made to fit any diameter or type tubing by attaching through small holes in the base. Nos. 50,103-Y and 50,108-Y are for refractors and have focus travel of over 4". Will fit our 2⅞" I.D. and our 3⅞" I.D. aluminum tubes respectively.

Stock #50,077-Y (less diagonal holder) $9.95 ppd.
Stock #60,035-Y (diagonal holder only) 1.00 ppd.
Stock #50,103-Y (for 2⅞" I.D. tubing) 12.95 ppd.
Stock #50,108-Y (for 3⅞" I.D. tubing) 13.95 ppd.

HUYGENS EYEPIECES

Here are some really terrific values in eyepieces! The three eyepieces listed below are manufactured by one of the world's best producers of optical components. We have searched the world's markets, including Germany and France, to find a real quality eyepiece. The image clarity, the workmanship evidenced in the metal parts, will prove the skill and experience of Goto Optical Company, Tokyo. Guaranteed terrific buys!

HUYGENS TYPE — STANDARD 1¼" DIAMETER
6-mm. (¼") Focal Length
Stock #30,063-Y .... $8.50 ppd.

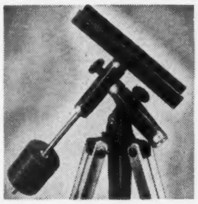
12.5-mm. (½") Focal Length
Stock #30,064-Y .... $8.00 ppd.

COMBINATION EYEPIECE — 10-mm. and 20-mm.
Stock #30,065-Y .... $9.00 ppd.

7X — FINDER TELESCOPE — ACHROMATIC

Stock #50,080-Y Finder alone, less ring mounts $9.95
Stock #50,075-Y Ring mounts per pr. $3.95

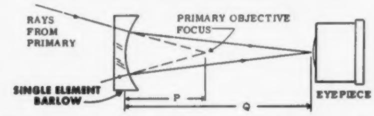
HEAVY-DUTY EQUATORIAL MOUNT AND TRIPOD for 6"-8" REFLECTING TELESCOPE



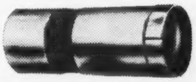
Heavy cast base with sturdy 32" long hardwood legs. 1" shafts. Boston bronze bearings to provide a uniform film of lubrication over entire bearing surface and assure smooth operation. Big locking knobs 1¾" on both declination and polar axes. Polar axis variable for latitude adjustment. 12" cradle securely holds 3" to 10" tubes. Beautifully finished in baked black wrinkle paint. Legs can be removed easily for permanent post mounting. Height 38", weight 32 lbs.

Stock #85,023-Y .... $49.50 f.o.b.

DOUBLE AND TRIPLE YOUR TELESCOPE'S POWER WITH A BARLOW LENS



WHAT IS A BARLOW? A Barlow lens is a negative lens used to increase the power of a telescope without resorting to short focal length eyepieces, and without the need for long, cumbersome telescope tubes. Referring to the diagram above, a Barlow is placed the distance P inside the primary focus of the mirror or objective. The Barlow diverges the beam to a distance Q. This focus is observed with the eyepiece in the usual manner. Thus, a Barlow may be mounted in the same tube that holds the eyepiece, making it very easy to achieve the extra power. The new power of the telescope is not, as you might suppose, due to the extra focal length given the objective by the difference between P and Q. It is defined as the original power of the telescope times the quotient of P divided into Q!



Beautiful chrome mount. We now have our Barlow lens mounted in chrome-plated brass tubing with special spacer rings that enable you to vary easily the power by sliding split rings out one end and placing them in other end. Comes to you ready to use. Just slide our mounted lens into your 1¼" I.D. tubing, then slide your 1¼" O.D. eyepieces into our chrome-plated tubing. Two pieces provided, one for regular focal length eyepieces and one for short focal length ones.

Remember, in addition to doubling and tripling your power, a Barlow lens increases your eye relief and makes using a short focal length eyepiece easier.

Don't fail to try one of these. Many people do not realize the many advantages of a Barlow and the much greater use they can get from their telescopes. Our Barlow has a focal length of — 1⁹⁄₁₆". We have received many complimentary letters about this lens. So sure are we that you will like it that we sell it under a 30-day guarantee of satisfaction or your full purchase price returned — no questions asked. You can't lose, so order today.

Stock #30,200-Y Mounted Barlow lens $8.00 ppd.

ATTENTION — BEGINNERS AND JUNIOR ASTRONOMY CLUBS

To solve the problem of low-cost lenses of good quality for a beginner's telescope we have had these achromatic lenses designed and mass produced. Our first shipment is in. They are swell!

ACHROMATIC OBJECTIVE, 32-mm. diameter (1¼"), F. L. 31". (Will get 62X with ½" eyepiece; 124X with ¼" eyepiece.)

Stock #30,201-Y .... $2.50 ppd.

ACHROMATIC OBJECTIVE, 42-mm. diameter (1-21/32"), F.L. 41". (Will get 41X with 1" eyepiece; 82X with ½"; and 164X with ¼".)

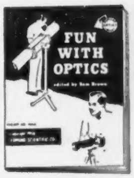
Stock #30,202-Y .... $4.00 ppd.

PRISM STAR DIAGONAL

For comfortable viewing of the stars near the zenith or high overhead on refractor telescopes using standard size (1¼" O.D.) eyepieces, or you can make an adapter for substandard refractors. Contains an excellent quality aluminized right-angle prism. Tubes are satin chrome-plated brass. Body is black wrinkle cast aluminum. Optical path of the system is about 3½".

Stock #70,077-Y .... $12.00 ppd.

FUN WITH OPTICS



New booklet, 32 pages. Completely illustrated. Shows you how to build many types of optical instruments; plus lens primer showing various types of lenses and how they work, optical illusions, etc.

Simple, easy-to-follow directions for building astronomical telescopes, terrestrial telescopes, artist's drawing projectors, reflex slide viewers, magnifiers, miniature monoculars, transparency projectors and many other optical instruments.

No technical knowledge is needed. Youngsters or grownups can have a lot of fun learning about optics and building their own optical instruments using lenses, prisms, etc., purchased from us.

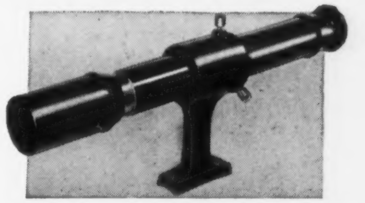
Stock #9050-Y .... $.50 ppd.

"MAKE-YOUR-OWN" 4¼" MIRROR KIT

The same fine mirror as used in our telescopes, polished and aluminized, lenses for eyepieces and diagonal. No metal parts.

Stock #50,074-Y .... $16.25 ppd.

6X FINDER TELESCOPE



Has crosshairs for exact locating. You focus by sliding objective mount in and out. Base fits any diameter tube — an important advantage. Has 3 centering screws for aligning with main telescope. 20-mm. diam. objective. Weighs less than ½ pound.

Stock #50,121-Y .... $8.00 ppd.

MISCELLANEOUS ITEMS

KELLNER EYEPIECE — 2" focal length (1¼" O.D.). Mount of black anodized aluminum.

Stock #30,189-Y .... $6.00 ppd.

60° SPECTROMETER PRISM — Polished surfaces 18-mm. x 30-mm. — flat to ½ wave length.

Stock #30,143-Y .... $8.25 ppd.

BRASS TUBING

2 pieces, 3" long, slide fitting. Blackened brass. I.D. 1-3/16". O.D. 1-5/16".

Stock #40,165-Y .... $1.75 ppd.

30-day Money Back Guarantee as with all our Merchandise!

BE SURE TO GET FREE CATALOG "Y"
Fantastic variety—never before have so many lenses, prisms, optical instruments, and components been offered from one source. Positively the greatest assembly of bargains in all America. Imported! War Surplus! Hundreds of other hard-to-get optical items. Write for Free Catalog "Y."

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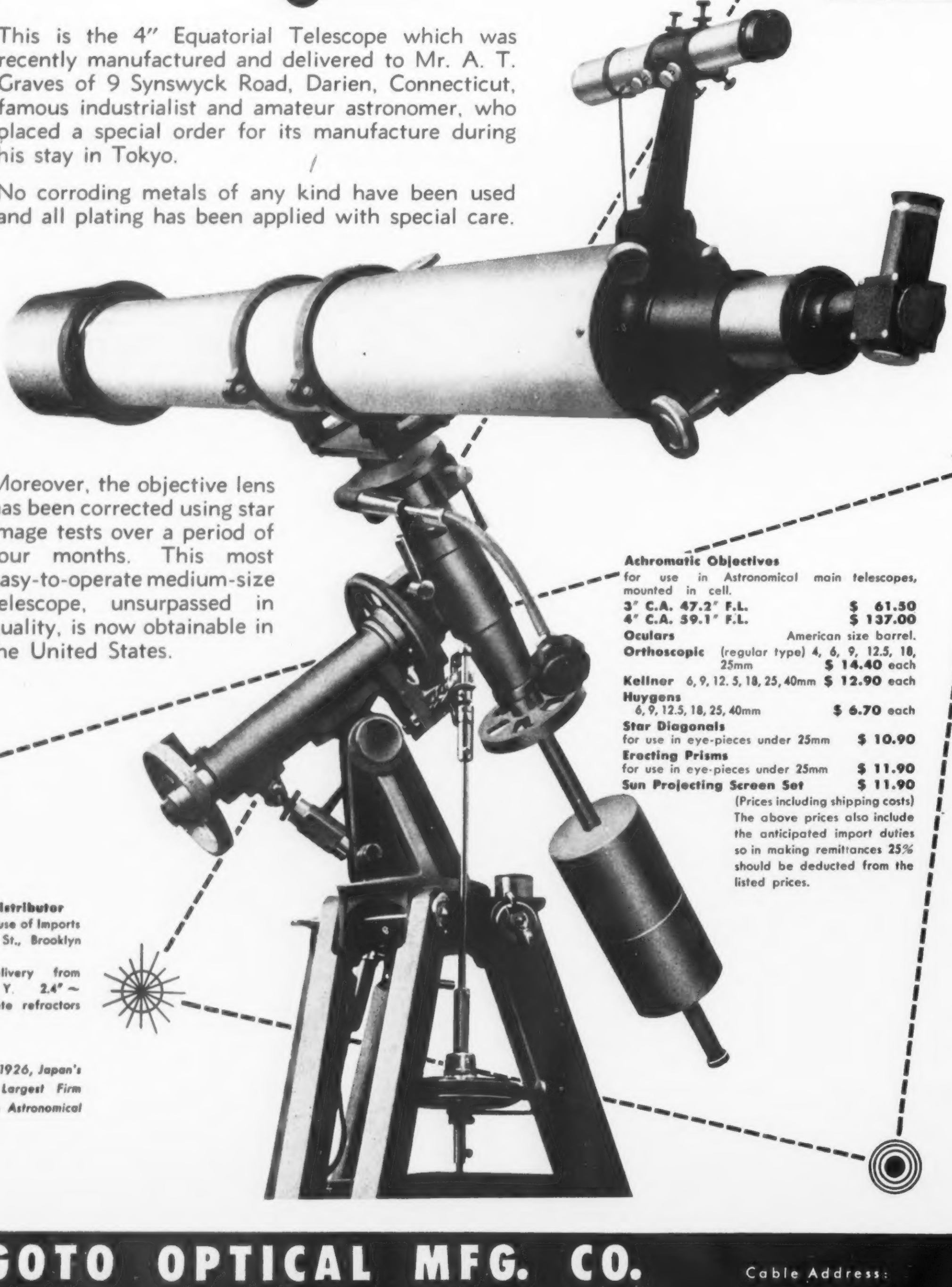
BARRINGTON • NEW JERSEY

Japan's Finest Telescopes now available for American Astronomers

GOTO
TOKYO

This is the 4″ Equatorial Telescope which was recently manufactured and delivered to Mr. A. T. Graves of 9 Synswyck Road, Darien, Connecticut, famous industrialist and amateur astronomer, who placed a special order for its manufacture during his stay in Tokyo.

No corroding metals of any kind have been used and all plating has been applied with special care.



Moreover, the objective lens has been corrected using star image tests over a period of four months. This most easy-to-operate medium-size telescope, unsurpassed in quality, is now obtainable in the United States.

Achromatic Objectives
for use in Astronomical main telescopes, mounted in cell.

3″ C.A. 47.2″ F.L.	**$ 61.50**
4″ C.A. 59.1″ F.L.	**$ 137.00**
Oculars	American size barrel.
Orthoscopic (regular type) 4, 6, 9, 12.5, 18, 25mm	**$ 14.40** each
Kellner 6, 9, 12. 5, 18, 25, 40mm	**$ 12.90** each
Huygens 6, 9, 12.5, 18, 25, 40mm	**$ 6.70** each
Star Diagonals for use in eye-pieces under 25mm	**$ 10.90**
Erecting Prisms for use in eye-pieces under 25mm	**$ 11.90**
Sun Projecting Screen Set	**$ 11.90**

(Prices including shipping costs) The above prices also include the anticipated import duties so in making remittances 25% should be deducted from the listed prices.

Sole U. S. Distributor
S. E. Laszlo House of Imports
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Prompt Delivery from Brooklyn, N. Y. 2.4″ ~ 6″ for complete refractors

Established in 1926, Japan's Oldest and Largest Firm Specializing in Astronomical Telescopes

GOTO OPTICAL MFG. CO.
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OBSERVER'S PAGE

Universal time is used unless otherwise noted.

Amateur Photography of the Northern Lights

WITH modern high-speed films and developers, the average amateur's camera can be used for aurora photography. Here are some suggestions based on the instructions for observers issued by the IGY Auroral Data Center at Cornell University. The visual aurora observing program during the IGY was described by D. S. Kimball and C. W. Gartlein in *Sky and Telescope*, for May, 1957, page 327.

Cameras, films, and exposures. Cameras with lenses that are f/4.5 or faster will give best results. Most aurora pictures will be taken with the shutter on "time," but if a camera has no such setting, then the lever for "bulb" must be held open during the exposure. The length of the exposure requires that the camera be firmly supported, not hand-held. A good, sturdy tripod that can be easily adjusted to point the camera to any part of the sky is recommended.

Motion-picture cameras can be used, with frames exposed for 10 to 20 seconds, one or two per minute for a medium aurora. For brilliant displays shorter exposures and a faster succession of frames are desirable. In 8-mm. and 16-mm., use Kodak Tri-X Pan Reversal film.

Black-and-white films for 35-mm. cameras are: Du Pont S-X Pan, Kodak Tri-X, Ilford HP3 and HPS. For larger cameras, using roll film and film packs: Ilford HP3 and Kodak Tri-X. In sheet film: Ansco Triple-S Pan, Du Pont High-Speed Pan type 428, Kodak Royal Ortho, Royal Pan, and Royal-X Pan.

The film and developer combination should yield an ASA exposure index of 200 daylight or faster. The following trial exposures are recommended for medium to bright auroras:

Aperture Ratio	*Exposure Range*
f/1.5	3-10 sec.
f/2	6-20 sec.
f/3.5	18-60 sec.
f/4.5	30-100 sec.

These exposure times are subject to wide variation, depending on the aurora and the condition of the sky. Do not exceed the values in the table if bright moonlight is present. But if the aurora is low or weak, try an occasional exposure four to eight times as long as in the table, to insure that some pictures will be successful. The shutter can remain open until the aurora moves perceptibly.

On the other hand, after a successful negative is obtained, shorter times than those in the table should be tried, for this may give sharper auroral details.

Polaroid Land cameras can be used for auroral work, but the Polaroid coupled shutter and diaphragm will probably prove unsatisfactory. A Polaroid camera with a standard lens and shutter can be used with film types 32, 42, and 44, to take pictures in which the results are immediately available. The new Polaroid transparency film, which has an ASA index of 1000, might make an ideal medium for this work.

Color emulsions have been made much

This rayed band was photographed during the spectacular aurora of September 18, 1941, by Kurt W. Opperman, Riverhead, New York. He used an f/2 35-mm. lens, exposing for 30 seconds on Ultra-speed Pan film.

Astronomy Films

16-mm. sound, 400-foot reels

I THE SUN; II THE MOON; III SOLAR SYSTEM; IV MILKY WAY; V EXTERIOR GALAXIES.

2 x 2 SLIDES

35-mm. STRIPS OF SLIDES

THROUGH **200-INCH** AND OTHER GREAT TELESCOPES

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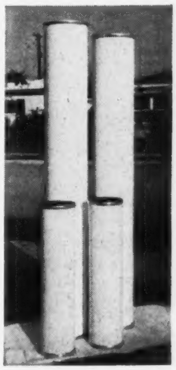

FIBERGLASS TUBES

- Light weight
- Reinforced
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- Low thermal conductivity
- Rigid strength
- Perfectly round

Also presenting sun projectors of advanced styling.

(Patent pending)

W. R. PARKS
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Tujunga, Calif.

Announcing the . . .

STELLASPHERE and STELLA-NAVIGATOR

Two new finders: one for the constellations, and the other for navigation stars. Practical for 10 degrees on each side of 40 degrees north latitude, making them useful in the United States and Canada, and in a like latitude belt around the earth. Designed by the late William H. Barton, Jr., once curator of astronomy at the Hayden Planetarium in New York.

The STELLA-NAVIGATOR fills an educational need. Young folks who incline either to air or sea travel can learn the names and locations of the principal navigation stars, using the finder as a guide to the sky.

A data folder is in preparation that will go with the finders; those purchasing them now will receive the folder as soon as it is ready. Don't delay your order—you'll want both!

STELLASPHERE or STELLA-NAVIGATOR ....$1.50 each

We are mailing many sets of our Constellation Post Cards and our Star Games, which have 30 different pictures in each set. Repeat orders for as many as five sets attest to their popularity. Have you yours yet? White stars on blue background. Post Cards or Star Game ....**$1.00 each**

SPECIAL OFFER: Star Game or Constellation Post Cards, plus the four items below only **$2.00**

Know Your Stars, C. L. Colgrove.........**35¢**
Solar System Data, C. L. Colgrove........**35¢**
Junior Star Finder, C. L. Colgrove........**50¢**
Lunar Map, Sky Publishing Corp..........**25¢**

As usual, we have many books, including Sky and Telescope *and its publications. Write for circulars, describing these and our chart and slide sets.*

ASTRONOMY CHARTED

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faster than they were a few years ago. Several color films can be specially developed to yield ASA indexes of 100 or more. With an f/1.5 lens, exposures of longer than 20 seconds will probably be necessary, unless the display is unusually bright. Use a haze filter to eliminate the ultraviolet.

What to photograph. Each auroral picture should contain some identified stars or objects of known direction and elevation, such as poles or trees. The observer should select his site in advance and measure these data. In the absence of such facts, the elevation of the center of the field of view should be estimated and its direction found with a compass.

Photographs based on the following list may have scientific value:

Arcs, where they cross the meridian.

Isolated long rays, with the altitudes of their top and bottom points.

Narrow homogeneous arcs (only $\frac{1}{2}°$ to 1° in width where they cross the meridian), or a succession of pictures to show such an arc's entire length.

Red forms, even if very diffuse, provided they are 15° or more above the horizon.

Zenith forms, such as an arc nearly overhead, will be especially valuable; point the camera straight up.

Diffuse forms, such as glows and patches, are particularly important for southern observers, as the photographic outlines of these may be our only means of determining the character and height of these great auroras.

Sequences showing the changing pattern of the aurora, taken at intervals of 5 to 15 minutes.

Motion pictures by lapse-time method to show changing forms, drift motion, and rising arcs.

To be of value, each print sent to the IGY Auroral Data Center, Cornell University, Ithaca, N. Y., should be accompanied with information on the azimuth and elevation of the center of the field, as well as the latitude and longitude of the observer, the double date, standard time, time zone, exposure time, and the designations of any bright stars. Additional remarks concerning the kind of camera, lens, film, and development should also be made, and these will be especially useful on pictures submitted to *Sky and Telescope* for possible reproduction. Take care not to mar prints by writing on their backs.

Photographers south of 40° latitude in the eastern United States, and those south of 45° in the West, should take pictures of the kinds listed above as frequently as possible. In the northern states and Canada, the aurora will be photographed on a regular program, but amateur photography may be a useful supplement. Zenith photography by northern observers, and records of diffuse forms by southern observers will be especially valuable, as has been mentioned.

Warning: After each exposure, check your camera lens to see whether or not dew has deposited on it, for such dewing reduces the light transmission and nothing may register on the film.

VERY HIGH LUNAR MOUNTAIN?

An Oakland, California, amateur suspects that a peak in the Leibnitz Mountains near the south polar limb of the moon may have a height of more than eight miles. John E. Westfall reports his observations and presents drawings in the *Strolling Astronomer, 10,* Nos. 11 and 12, published in May.

The very tall mountain was one of two seen in silhouette at the edge of the moon on January 18, 1954. Their distance apart was $30\frac{1}{2}$ miles, and the lower peak was measured as 30,400 feet, not unexpected in the Leibnitz range. But the taller peak came out 43,500 feet, and a second observation on January 8, 1955, gave 45,900 feet.

Mr. Westfall used a 4-inch refractor, but he does not state exactly how the measurements were made nor how the heights were calculated. He defines the peak's position as on the moon's limb back of Cabaeus, and about 180 miles from the south pole. To see the peak in profile, the moon's libration in latitude must be at about its mean value, and the sun's colongitude between 70° and 100°.

SKY-SCOPE

COMPLETE AS ILLUSTRATED $29.75

With standard 60-power eyepiece

The full 3½-inch diameter reflecting-type astronomical telescope that even the telescope makers talk about.

It has been sold for more than 17 years and now is on display in at least two U. S. planetaria. It will show mountains and craters on the moon, Saturn's rings, Jupiter's four moons and the planet's markings, and close double stars with guaranteed observatory clearness. Skyscope enjoys worldwide distribution.

Every instrument, with its ¼-wave, aluminized mirror, is individually tested before being packed for shipment. We suggest that before buying you inquire at almost any local astronomy society about the efficiency of Skyscope. *100% American-made.*

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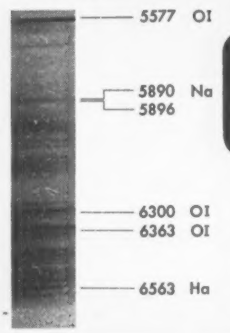

Dr. D. K. Berkey, Dept. of Physics and Astronomy, Colgate University, uses spectrograph built around B&L grating to record auroral spectra (Left) in Oslo, Norway.

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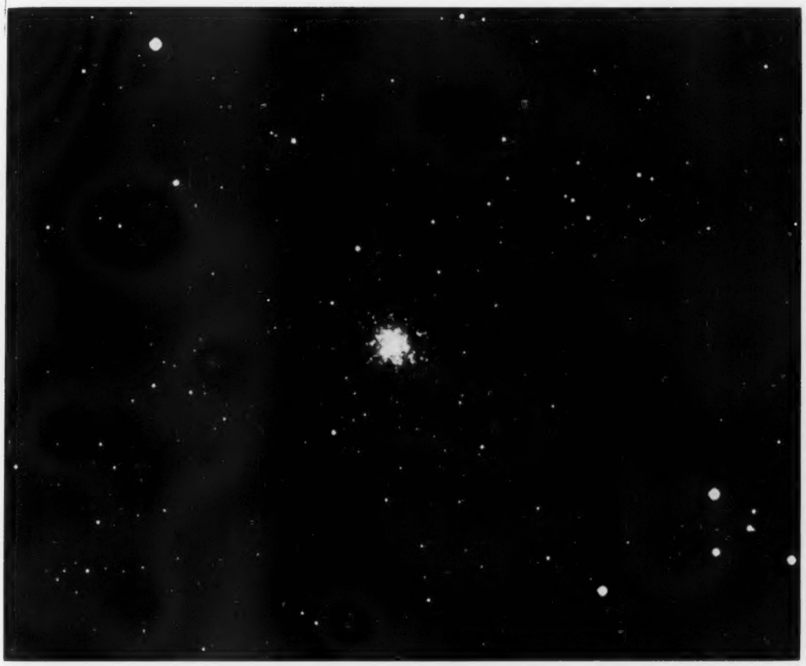
DEEP-SKY WONDERS

AUGUST is the best month for northern observers to study Sagittarius early in the evening. Go outside as soon as darkness falls and view the great star-clouds of the Milky Way along the southern horizon. The Teapot of Sagittarius lies partly imbedded in these clouds, and just above it (to the left of Lambda) is the famous globular cluster M22, NGC 6656. Its 1950 position is $18^h\ 33^m.3$, $-23°\ 58'$.

It is large as globular clusters go, 17 minutes of arc in diameter, and its magnitude of about 6 suggests it as a naked-eye test if you have transparent skies toward the south. Almost any telescope power will resolve the edges of this cluster, and binoculars give an interesting view. In large amateur instruments it is a fine subject over which you will linger for many minutes.

When Messier observed this object on June 5, 1764, with a Gregorian telescope magnifying 104 times, it appeared to have a diameter of 6′ and seemed to be a nebula that did not contain a single star. He pointed out that M22 had already been discovered by Abraham Ihle, as early as 1665 while observing Saturn. In 1833, Sir John Herschel described M22 in these words: "A magnificent globular cluster, gradually brighter in the middle, but not to a nucleus."

WALTER SCOTT HOUSTON
Rte. 3, Manhattan, Kans.



The globular cluster Messier 22 was photographed by Strathmore R. B. Cooke, of Minneapolis, Minnesota, with his 6-inch f/3.2 Schmidt camera, on September 27, 1954. The scale is about 1′ to 1.4 millimeters. North is upward.

UNIVERSAL TIME (UT)

TIMES used on the Observer's Page are Greenwich civil or Universal time, unless otherwise noted. This is 24-hour time, from midnight to midnight; times greater than 12:00 are p.m. Subtract the following hours to convert to standard times in the United States: EST, 5; CST, 6; MST, 7; PST, 8. If necessary, add 24 hours to the UT before subtracting, in which case the result is your standard time on the day preceding the Greenwich date shown.

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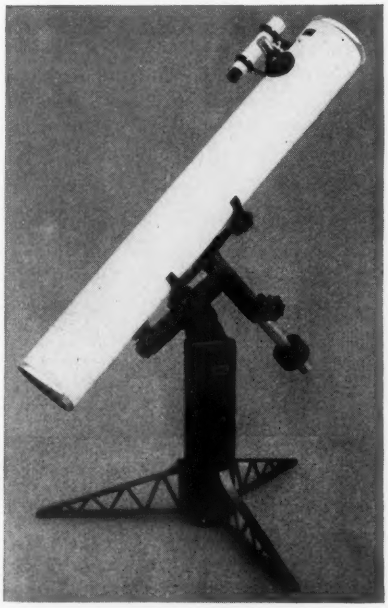

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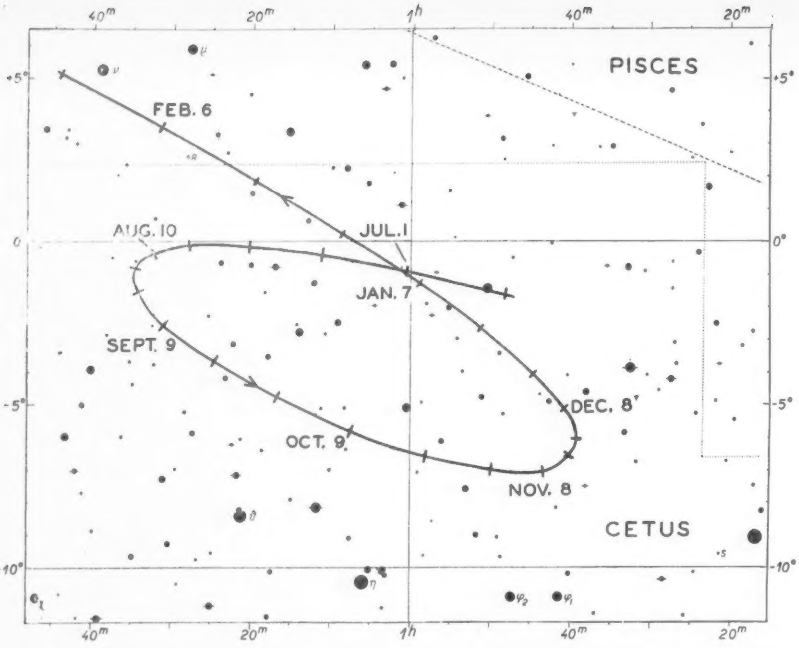

The track of the minor planet Vesta in Cetus and Pisces during the coming half year is here plotted in the Skalnate Pleso "Atlas of the Heavens."

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Classified advertising costs 20 cents a word, including address; minimum charge, $3.00 per ad. Only one *for sale* ad per issue for each advertiser. *Remittance must accompany order.* Insertion is guaranteed only on copy received by the 20th of the second month before publication; otherwise, insertion will be made in next issue. We cannot acknowledge classified ad orders. Sky Publishing Corporation assumes no responsibility for statements made in classified ads, nor for the quality of merchandise advertised. Write Ad Dept., *Sky and Telescope*, Harvard Observatory, Cambridge 38, Massachusetts.

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OCTOBER OPPOSITION OF ASTEROID VESTA

The brightest of the asteroids is Vesta. It comes to opposition to the sun on October 11th, when it will be 140 million miles from the earth and of visual magnitude 6.8—convenient for amateur observations with binoculars.

Predicted magnitudes for the first of each month are: July 8.2, August 7.6, September 7.1, October 6.7, November 7.0, December 7.6, and January 8.3. The limiting magnitude of stars plotted in the Skalnate Pleso chart at the left is 7.75.

At closer oppositions, Vesta can sometimes be seen with the naked eye, the only asteroid for which this is possible by observers with normal eyesight.

METEOR OBSERVING

The 1956 meteor observing program of the Whittier Astronomical Society was very successful, and we are carrying out another program for this year. Our six-member team spent about 500 man-hours of observing time during a series of seven trips to a mountain site near Lake Arrowhead and to our own desert location near Yucca Valley.

The writer observed 2,570 meteors; P. Dobson, 2,560; C. Swanson, 2,295; M. Daugherty, 1,589; W. Allen, 374; and M. Thiebaux, 265. The reports were submitted to the American Meteor Society for processing.

The Delta Aquarids and Perseids were the principal showers observed. One member plotted 60 meteors per hour during the Perseids. During the year we saw a meteor train of 17 seconds duration, a 66-degree-long meteor lasting six seconds, five stationary meteors, and four meteors with curved paths. The brightest seen was a −6-magnitude green fireball.

Other societies wishing information concerning the setting up of similar group programs may contact the undersigned.

RICHARD N. STURTRIDGE
8416 Davista Drive
Whittier, Calif.

SUNSPOT NUMBERS

May 1, 124, 118; **2**, 125, 121; **3**, 119, 123; **4**, 85, 106; **5**, 106, 92; **6**, 106, 142; **7**, 117, 136; **8**, 134, 150; **9**, 156, 162; **10**, 151, 195; **11**, 156, 211; **12**, 190, 207; **13**, 161, 202; **14**, 205, 214; **15**, 179, 210; **16**, 197, 185; **17**, 159, 179; **18**, 182, 186; **19**, 172, 178; **20**, 187, 179; **21**, 173, 195; **22**, 172, 155; **23**, 174, 184; **24**, 185, 195; **25**, 126, 150; **26**, 116, 140; **27**, 137, 140; **28**, 146, 147; **29**, 163, 154; **30**, 159, 172; **31**, 134, 180. Means for May: 151.5 American, 164.8 Zurich.

Above are given the date, the American number, then the Zurich number. These are observed mean relative sunspot numbers, the American computed by Dr. Sarah J. Hill from AAVSO Solar Division observations, the Zurich numbers from Zurich Observatory and its stations in Locarno and Arosa.

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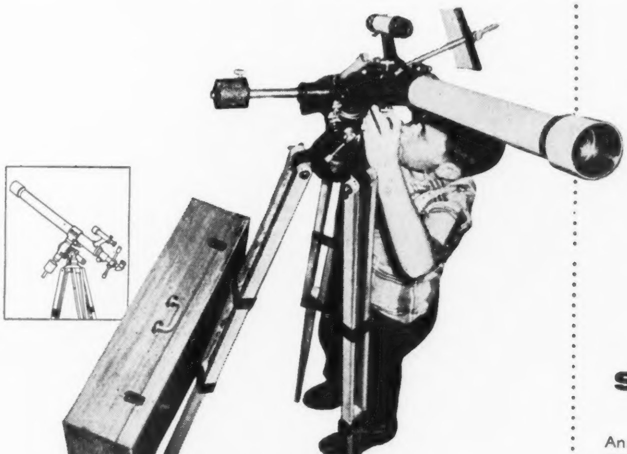

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SATURN TO BE OCCULTED

On the evening of Saturday, August 31st, amateurs in the south central and southwestern parts of the United States will be able to watch an occultation of the planet Saturn by the moon.

The phenomenon will hardly be seen by anyone much to the east of St. Louis, Missouri, where the ringed planet will go behind the dark edge of the moon at 10:24.4 p.m. Central standard time, only about six minutes before moonset. Farther west and south, disappearance will occur with the moon higher in the sky. At Dallas, Texas, it is at 10:24.6 CST, with the moon still an hour above the western horizon. Watchers in California will be able to see both the immersion and emersion of the planet, the times for Berkeley being 7:59.8 and 8:46.7 p.m. PST.

From Vancouver, Canada, Saturn will escape occultation, passing close to the northern limb of the moon, according to the *American Ephemeris*. Evidently, there will be a narrow zone across the northwestern United States where Saturn will be at most partly covered by the moon. As mentioned on page 167 of the February issue, eyewitness reports of grazing occultations are quite rare, so amateurs in the Northwest have an opportunity to try for an unusual observation.

Amateurs within the region of visibility at places other than those mentioned above can readily tell when the phenomenon will occur, using the data given under Occultation Predictions.

For example, when will immersion of Saturn occur for an observer at Los Angeles, California, in longitude **Lo** = +118°.2, latitude **L** = +34°.1? The corresponding co-ordinates of the nearest standard station, **H**, are **LoS** = +120°.0, **LS** = +36°.0. Then

Lo − **LoS** = +118°.2 − 120°.0 = −1°.8,
L − **LS** = +34°.1 − 36°.0 = −1°.9.

The predicted data for immersion at the standard station are: Universal time = 4:01.5; **a** = −1.4, **b** = +0.8. Multiplying **Lo** − **LoS** by **a** and **L** − **LS** by **b**:

−1.8 × −1.4 = +2.5,
−1.9 × +0.8 = −1.5.

Immersion at Los Angeles is therefore at 4:01.5 + 2.5 − 1.5 = 4:00.5 on September 1st, Universal time, or 28:00.5 on August 31st. To obtain Pacific standard time, subtract eight hours, giving 20:00.5, or 8:00.5 p.m. PST, on August 31st.

OCCULTATION PREDICTIONS

August 3-4 **Kappa Librae** 5.0, 15:39.5 −19-32.5, 8. Im: **A** 1:23.4 −1.8 −1.9 137; **B** 1:16.4 −1.7 −1.5 131; **C** 1:22.1 −1.9 −2.2 145; **D** 1:09.1 −1.8 −1.5 135.

August 6-7 **21 Sagittarii** 5.0, 18:22.8 −20-34.0, 11. Im: **A** 1:17.0 . . . . . . 154; **B** 1:09.5 . . . . . . 144; **D** 1:02.2 . . . . . . 151.

August 8-9 **Beta Capricorni** 3.2, 20:18.6 −14-55.1, 13. Im: **F** 10:01.4 −0.5 −0.2 66; **H** 9:53.9 −0.1 +2.2 15. Em: **H** 10:42.1 −1.8 −2.7 297.

August 14-15 **Delta Piscium** 4.6, 0:46.4 +7:21.1, 19. Em: **A** 6:11.8 . . . . . . 314; **C** 6:01.7 . . . . . . 309.

August 27-28 **Alpha Virginis** 1.2, 13:22.9 −10-56.2, 3. Im: **F** 20:31.0 . . . . . . 50; **H** 19:44.6 −1.5 +1.5 79. Em: **F** 21:02.6 . . . . . . 5; **H** 20:40.6 −0.7 −1.4 333.

August 31-September 1 **Psi Ophiuchi** 4.6, 16:21.6 −19-56.3, 7. Im: **C** 2:31.6 −0.2 +1.2 30; **F** 2:02.2 . . . . . . 37.

For places within any of the eight circles on this map, fairly accurate local predicted times of occultations by the moon are easily obtained. Take the prediction for the standard station at the center of the circle, and apply the small corrections given here.

August 31-September 1 **Saturn** 0.7, 16:26.1 −20-04.7, 7. Im: **E** 4:23.5 −0.3 −0.5 61; **F** 4:24.9 −0.8 −0.7 78; **H** 4:01.5 −1.4 +0.8 43. Em: **H** 4:56.2 −1.9 −2.7 316.

For stations in the United States and Canada, usually for stars of magnitude 5.0 or brighter, data from the *American Ephemeris* and the *British Nautical Almanac* are given here, as follows: evening-morning date, star name, magnitude, right ascension in hours and minutes, declination in degrees and minutes, moon's age in days, immersion or emersion; standard station designation, UT, **a** and **b** quantities in minutes, position angle on the moon's limb; the same data for each standard station westward.

The **a** and **b** quantities tabulated in each case are variations of standard-station predicted times per degree of longitude and of latitude, respectively, enabling computation of fairly accurate times for one's local station (long. **Lo**, lat. **L**) within 200 or 300 miles of a standard station (long. **LoS**, lat. **LS**). Multiply **a** by the difference in longitude (**Lo** — **LoS**), and multiply **b** by the difference in latitude (**L** — **LS**), with due regard to arithmetic signs, and add both results to (or subtract from, as the case may be) the standard-station predicted time to obtain time at the local station. Then convert the Universal time to your standard time.

Longitudes and latitudes of standard stations are:

A	+72°.5,	+42°.5	**E**	+91°.0,	+40°.0
B	+73°.6,	+45°.5	**F**	+98°.0,	+31°.0
C	+77°.1,	+38°.9	**G**	Discontinued	
D	+79°.4,	+43°.7	**H**	+120°.0,	+36°.0
			I	+123°.1,	+49°.5

COMET AREND-ROLAND

The following ephemeris for Comet 1956h has been computed by M. P. Candy, and is taken from *Circular* 1603 of the International Astronomical Union. It gives, for 0^h Universal time of every 10th day, the 1950 right ascension and declination, and the expected magnitude of the comet:

July 31, 10^h 14^m.8, +57° 11′, 10.5. **August 10,** 10^h 31^m.9, +56° 55′, 10.9; **20,** 10^h 48^m.5, +56° 50′, 11.2; **30,** 11^h 04^m.8, +56° 57′, 11.5. **September 9,** 11^h 20^m.9, +57° 17′, 11.8; **19,** 11^h 36^m.9, +57° 49′, 12.0; **29,** 11^h 52^m.8, +58° 36′, 12.2. **October 9,** 12^h 08^m.8, +59° 39′, 12.4.

During this period, the comet will cross the bowl of the Big Dipper. As it recedes from both the earth and the sun, the distance from us will increase from 280 million to 306 million miles during August.

COMET ENCKE

This well-known periodic comet is poorly placed for observation during its 1957 return; on the date of perihelion passage, October 20th, Comet Encke will be about 6th magnitude, but within a few degrees from the sun and hence unobservable.

During September the comet will be visible with amateur telescopes in the morning sky, as it moves across the constellations Gemini and Cancer into Leo. The following ephemeris by S. G. Makower is from the *Handbook* of the British Astronomical Association. It gives for 0^h UT on every fifth day the 1950 right ascension and declination, and the expected visual magnitude of Comet Encke. Like all predictions of comet brightnesses, these should be taken as only a rough guide.

August 30, 6^h 09^m.1, +34° 46′, 12.6. **September 4,** 6^h 45^m.0, +34° 38′, 12.0; **9,** 7^h 24^m.7, +33° 43′, 11.3; **14,** 8^h 07^m.4, +31° 48′, 10.6; **19,** 8^h 51^m.5, +28° 43′, 9.9; **24,** 9^h 35^m.1, +24° 31′, 9.1; **29,** 10^h 16^m.8, +19° 24′, 8.3. **October 4,** 10^h 56^m.0, +13° 40′, 7.3; **9,** 11^h 33^m.3, +7° 33′, 6.3.

MINIMA OF ALGOL

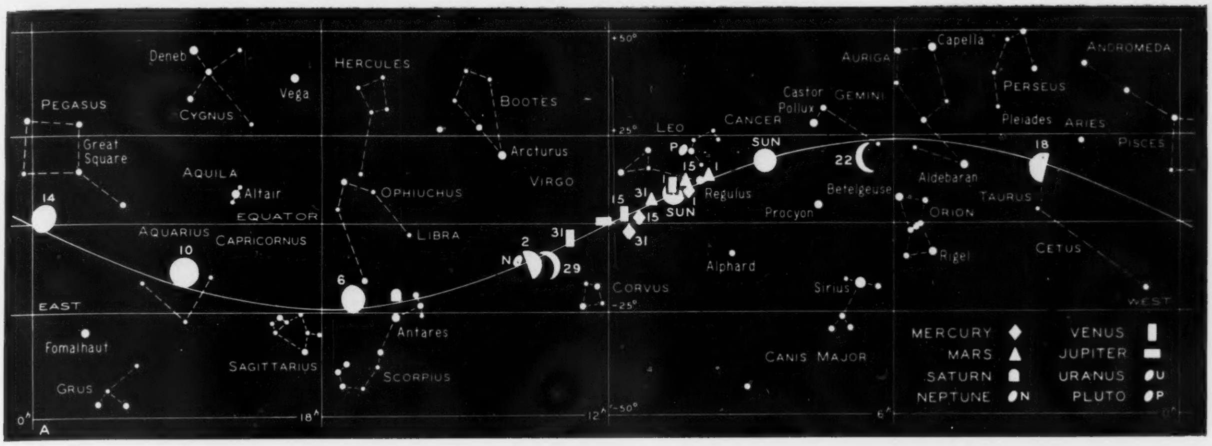
August 2, 16:08; 5, 12:57; 8, 9:45; 11, 6:34; 14, 3:22; 17, 0:11; 19, 21:00; 22, 17:49; 25, 14:37; 28, 11:25; 31, 8:14. September 3, 5:02; 6, 1:51.

These minima predictions for Algol are based on the formula in the 1953 *International Supplement* of the Krakow Observatory. The times given are geocentric; they can be compared directly with observed times of least brightness.

MOON PHASES AND DISTANCE

First quarter . . . . August 2, 18:55
Full moon . . . . August 10, 13:08
Last quarter . . . . August 18, 16:16
New moon . . . . August 25, 11:32
First quarter . . . . . . September 1, 4:34

	August	Distance	Diameter
Apogee	12, 14^h	252,400 mi.	29′ 23″
Perigee	25, 18^h	222,000 mi.	33′ 27″
	September		
Apogee	8, 17^h	252,500 mi.	29′ 24″



THE SUN, MOON, AND PLANETS THIS MONTH

The sun, on the ecliptic, is shown for the beginning and end of the month. The moon's symbols give its phase roughly, with the date marked alongside. Each planet is located for the middle of the month or for other dates shown. All positions are for 0^h Universal time on the respective dates.

Mercury comes to greatest elongation on August 13th, 27° 26′ east of the sun. The planet then sets one hour after the sun, and is of magnitude +0.6. This is not a favorable apparition for viewers in mid-northern latitudes.

Venus is a brilliant object in the western sky after sundown, setting 1½ hours later than the sun. In midmonth, Venus is of magnitude −3.4; telescopically its disk is 12″.5 in diameter and 84-per-cent illuminated. On August 22nd at 15^h UT, Venus passes 28′ south of Jupiter.

Mars, in Leo, will be too close to the sun for observation.

Jupiter may be seen low in the western sky, setting 1½ hours after the sun in mid-August. It is now a −1.3-magnitude object in western Virgo. The giant planet will occult the 8.9-magnitude star BD +1° 2647 on August 8th. Although visible in the eastern United States, the phenomenon takes place under unfavorable circumstances, Jupiter being very low in a bright twilight sky. The *Handbook* of the British Astronomical Association cites 0:55 UT as the time of the star's disappearance for Montreal, Canada, and 1:58 UT for reappearance as seen from Oxford, Mississippi. These times are generally valid over the eastern states.

Saturn will be visible only during evening hours, as eastern quadrature with the sun occurs on August 31st. Its motion changes from westward to eastward on the 12th, but little apparent displacement can be seen during the month, the ringed planet remaining about 6° north of Antares. On August 31st, an occultation of Saturn by the moon can be seen in some parts of the United States (see page 504). On that night, Saturn will be of magnitude +0.6, and the ring system will be inclined 25°.8 to our line of sight.

Uranus will be in the morning sky, but too close to the sun to be viewed.

Neptune can be observed only in the early evening hours. Optical aid is required to see this 8th-magnitude object, in very slow eastward motion about 4° west of Kappa Virginis. E. O.

VARIABLE STAR MAXIMA

August 4, X Monocerotis, 065**208**, 7.6; 6, RS Scorpii, 164844, 6.8; 9, S Ursae Majoris, 123961, 7.9; 12, R Leporis, 045**514**, 6.7; 14, T Herculis, 180531, 8.0; 17, S Hydrae, 084803, 7.9; 19, T Columbae, 051**533**, 7.6; 19, SS Virginis, 122001, 6.9; 28, R Sagittarii, 191**019**, 7.2; 29, T Centauri, 133**633**, 6.1; 31, R Virginis, 123307, 6.9.

September 1, R Corvi, 121**418**, 7.6; 3, T Cassiopeiae, 001755, 7.8; 4, R Lyncis, 065355, 7.9; 6, T Hydrae, 085**008**, 7.7; 7, R Centauri, 140**959**, 5.9; 10, RR Sagittarii, 194**929**, 6.6.

These predictions of variable star maxima are by the AAVSO. Only stars are included whose mean maximum magnitudes are brighter than magnitude 8.0. Some, but not all of them, are nearly as bright as maximum two or three weeks before and after the dates for maximum. The data given include, in order, the day of the month near which the maximum should occur, the star name, the star designation number, which gives the rough right ascension (first four figures) and declination (bold face if southern), and the predicted magnitude.

PREDICTIONS OF BRIGHT MINOR PLANET POSITIONS

Euterpe, 27, 9.6. August 30, 0:25.9 −0-02. September 9, 0:19.5 −0-52; 19, 0:11.2 −1-51; 29, 0:01.8 −2-54. October 9, 23:52.8 −3-49; 19, 23:45.4 −4-31.

Victoria, 12, 8.6. August 30, 0:02.9 +16-08. September 9, 23:56.2 +15-21; 19, 23:48.1 +14-02; 29, 23:40.2 +12-19. October 9, 23:33.9 +10-27; 19, 23:30.1 +8-41.

After the asteroid's name are its number and the magnitude expected at opposition. At 10-day intervals are given its right ascension and declination (1950.0) for 0^h Universal time. In each case the motion of the asteroid is retrograde. Data are supplied by the IAU Minor Planet Center at the University of Cincinnati Observatory.

AUGUST METEORS

Despite full moon on the 10th, the Perseid shower may be observed with good results during the first 15 days of August. The hourly rates will climb slowly for the first two weeks, attaining a peak on August 12th before decreasing rapidly. Each evening a few Perseids will be seen before midnight, and they will be most numerous before dawn. Under more favorable conditions, as in 1956, rates of 50 to 90 Perseids per hour have been reported by some observers.

These meteors are swift, and a large percentage are bright and leave trains. On the 12th, the moving radiant is at $3^h\ 04^m$, +58°, north of Gamma Persei. E. O.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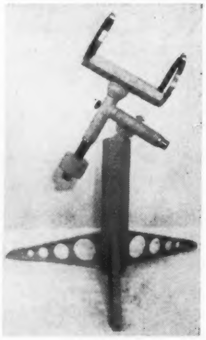

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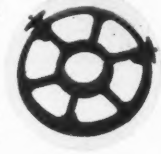

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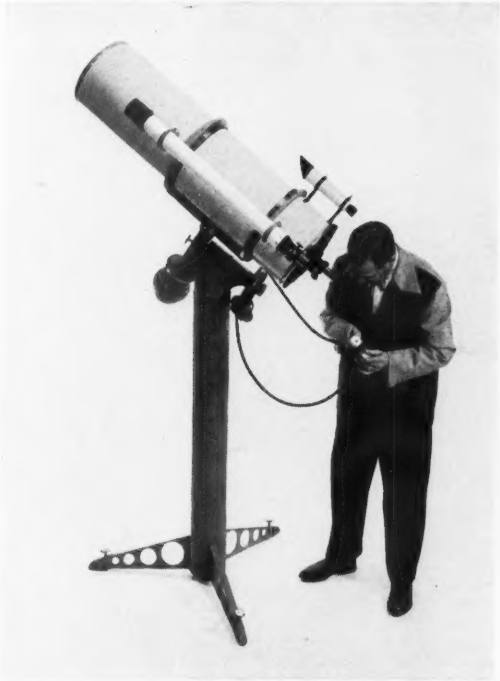

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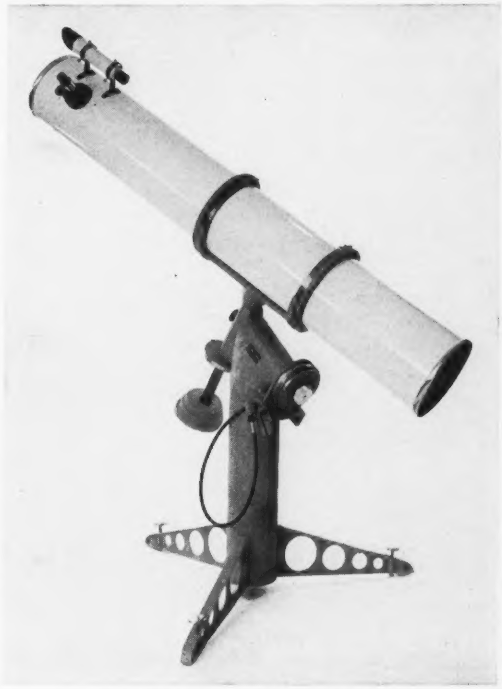

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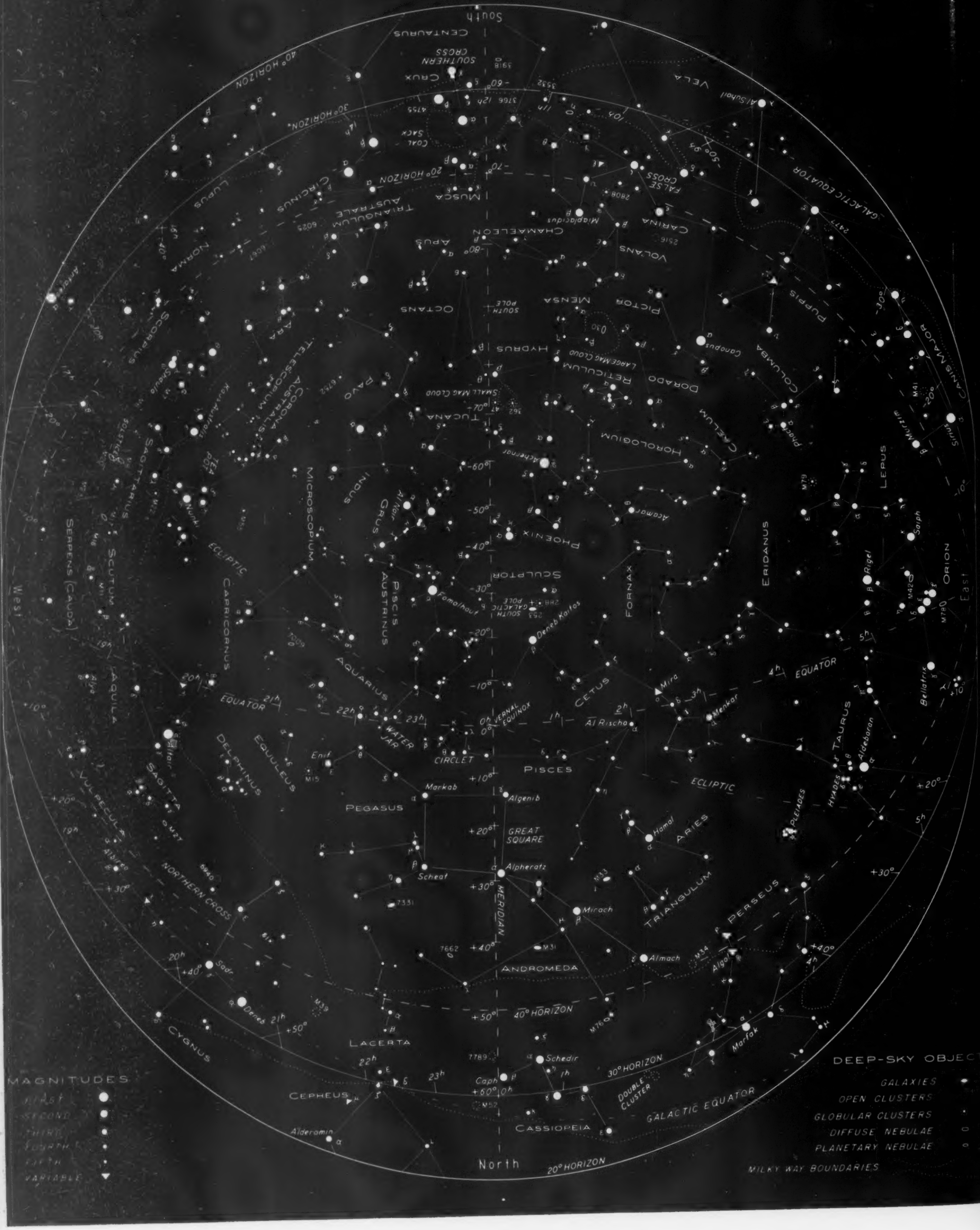
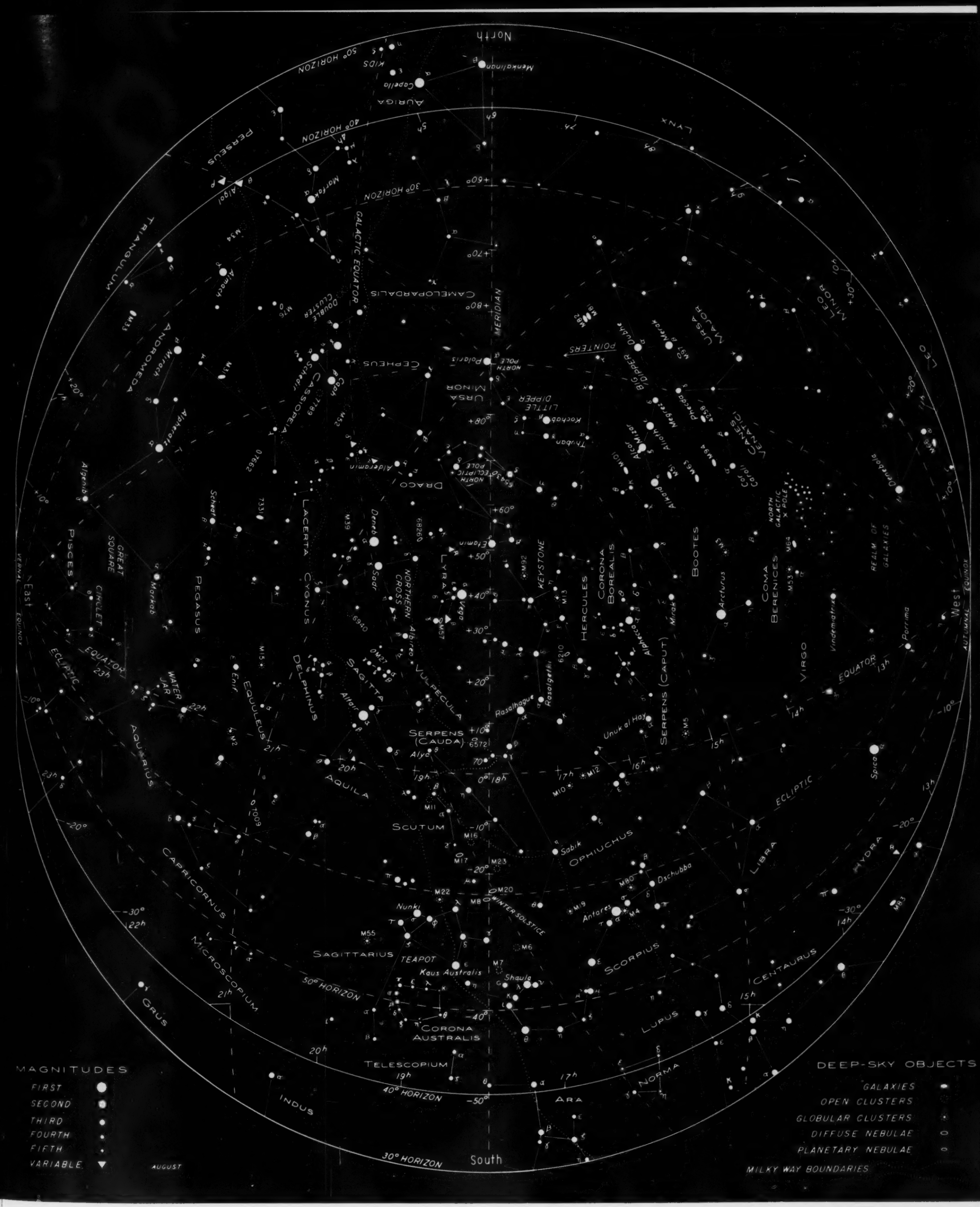


SOUTHERN STARS

The sky as seen from latitudes 20° to 40° south, at 11 p.m. and 10 p.m., local time, on the 7th and 23rd of October, respectively; also, at 9 p.m. and 8 p.m. on November 7th and 23rd. For other dates, add or subtract ½ hour per week.

For southern observers, Pegasus dominates the northern part of the sky, and he is not upside down as he is for northerners. Notice how two sides of the Great Square run north and south, one pointing up the sky toward Fomalhaut, the other to Deneb Kaitos.



STARS FOR AUGUST

The sky as seen from latitudes 30° to 50° north, at 9 p.m. and 8 p.m., local time, on the 7th and 23rd of August, respectively; also, at 7 p.m. on September 7th. For other dates, add or subtract ½ hour per week.

At this season, Ophiuchus and Serpens are well placed for study. Rasalhague is the brightest star near the meridian to the south of Vega. The head of the serpent forms an X below the Northern Crown, one of the five stars being quite a bit fainter than the others.

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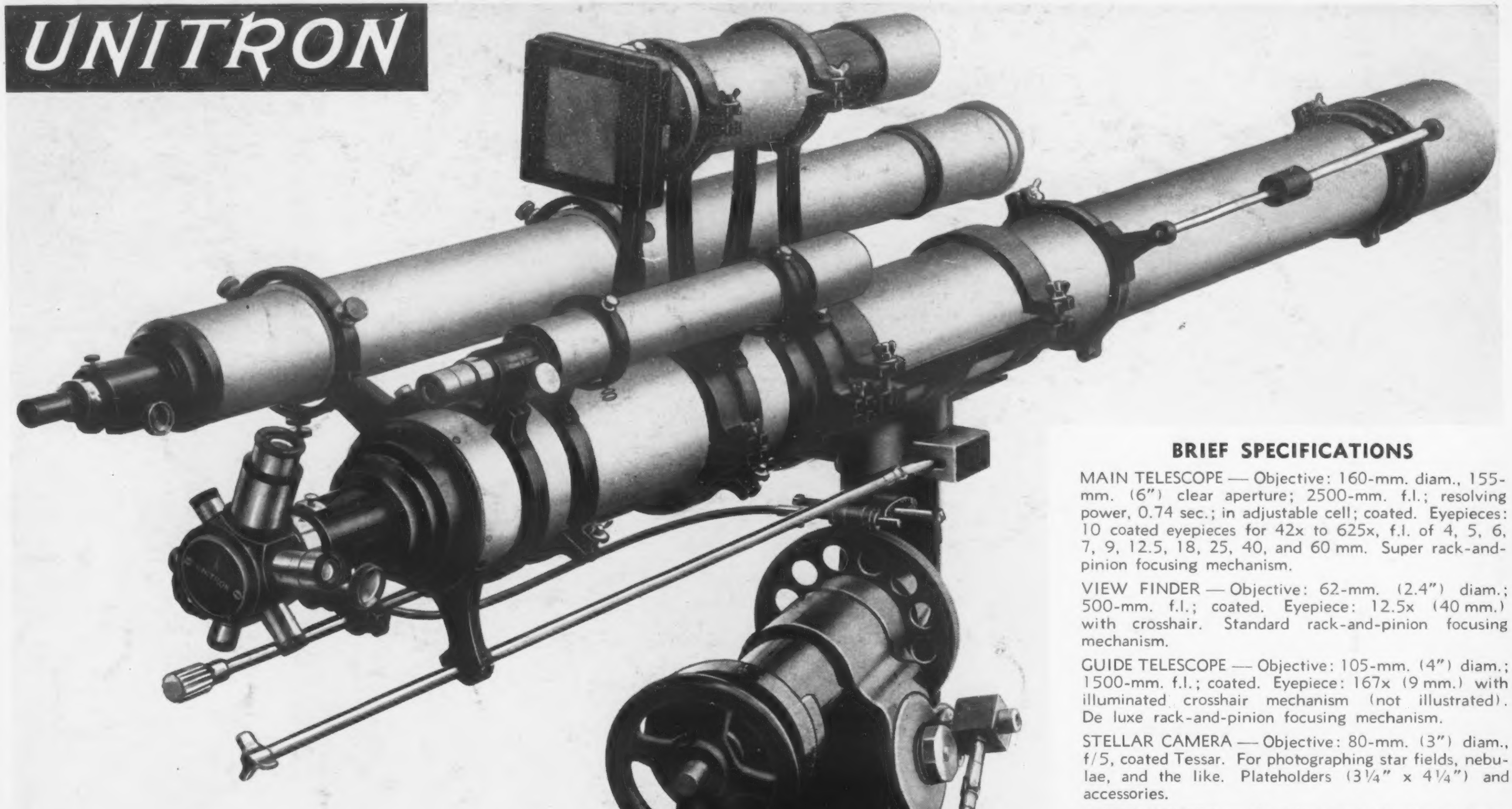

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See pages 490 and 491.

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